Engineering Library

UNIV. OF MICH. LIBRARY

ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY WILLIAM H. MAW AND B. ALFRED RAWORTH.

OFFICES FOR ADVERTISEMENTS AND PUBLICATION, 35 & 36, BEDFORD STREET, STRAND, LONDON, W.C. 2.

VOL. CV.—No. 2718.] *LONDON: FRIDAY, FEBRUARY* 1, 1918. [*Registered at the General Post Office as a Newspaper.*] PRICE 8d. BY INLAND POST...10d.

Aveling & Porter, Ltd.,
ROCHESTER, KENT.
and 72, CANNON STREET, LONDON.
STEAM ROLLERS. ROAD LOCOMOTIVES.
STEAM CULTIVATING MACHINERY.
STEAM WAGONS. TRACTORS.
CEMENT-MAKING MACHINERY. 6030

A. G. Mumford, Ltd.,
CULVER STREET WORKS, COLCHESTER.
ON ADMIRALTY AND WAR OFFICE LISTS.
ENGINES for Torpedo Boats, Yachts, Launches.
BOILER FEED PUMPS.
See Advertisement, page 31.
PATENT WATER-TUBE BOILERS.
AUTOMATIC FEED REGULATORS,
And Auxiliary Machinery as supplied to the Admiralty. 2179

Henry Butcher & Co.,
VALUERS AND AUCTIONEERS,
Specialising in the
ENGINEERING, FOUNDRY & METAL TRADES.
Also for
PLANT AND MACHINERY.
63 AND 64, CHANCERY LANE,
LONDON, W.C. 2.
'Phone: Holborn 2295. 6391
Telegrams: Penetrancy, Holb., London.

Cranes.—Electric, Steam,
HYDRAULIC and HAND.
of all types and sizes.
GEORGE RUSSELL & CO., LTD.,
Motherwell, near Glasgow. 6451

STEEL TANKS, PIPES, GASHOLDERS, &c.
Thos. Piggott & Co., Limited,
BIRMINGHAM. 4457
See Advertisement last week, page 108.

Plenty and Son,
LIMITED.
MARINE ENGINEERS, &c.
NEWBURY, ENGLAND. 9083

Tank Locomotives.
Specification and Workmanship equal to Main Line Locomotives.
R. & W. HAWTHORN, LESLIE & CO., LTD.,
ENGINEERS, NEWCASTLE-ON-TYNE. 6450

The Glasgow Railway Engineering Company,
GOVAN, GLASGOW. LTD.
London Office—12, Victoria Street, S.W.
MANUFACTURERS OF
RAILWAY CARRIAGE, WAGON AND TRAMWAY WHEELS & AXLES.
CARRIAGE & WAGON IRONWORKS, also CAST-STEEL AXLE BOXES. 3769

P. & W. MacLellan, Limited,
CLUTHA WORKS, GLASGOW.
MANUFACTURERS OF
RAILWAY CARRIAGES AND WAGONS,
OF EVERY DESCRIPTION.
RAILWAY IRONWORK, BRIDGES, ROOFING, &c.
Chief Offices: 129, Trongate, GLASGOW. Od 8547
Registered Offices: 108A, Cannon St., London, E.C.

Fuller, Horsey, Sons & Cassell,
SPECIALISTS
in the
SALE AND VALUATION
of
PLANT AND MACHINERY
and
ENGINEERING WORKS.
133, HIGH HOLBORN, LONDON, W.C. 1.

Invincible Gauge Glasses.
BUTTERWORTH BROS, Ltd.,
Newton Heath Glass Works,
Manchester. Od 9753

Iron and Steel
Tubes and Fittings.
6145
The Scottish Tube Co., Ltd.,
HEAD OFFICE: 34, Robertson Street, Glasgow.
See Advertisement page 47.

Yarrow & Co., Ltd.,
SHIPBUILDERS AND ENGINEERS,
GLASGOW.
SPEEDS UP TO 45 MILES AN HOUR.
PADDLE OR SCREW STEAMERS OF
EXCEPTIONAL SHALLOW DRAUGHT.
Repairs on Pacific Coast
by YARROWS, LIMITED, Victoria, British Columbia. 6093
SHIPBUILDERS, SHIP REPAIRERS AND ENGINEERS.

Campbells & Hunter, Ltd.
Gear Cutting.
Worm Wheels cut up to 12 ft. diam.
Bevel and Mitre Wheels planed up to 3 ft. diam.
DOLPHIN FOUNDRY, LEEDS. 4547

Yachts, Launches, or Barges,
Built complete with Steam, Oil or Petrol Motors, ; or Machinery supplied. Od 3551
VOSPER & CO., LTD., BROAD STREET, PORTSMOUTH

FOR
Sheet Metal Stampings or Pressings
write
GARTSHERRIE ENGINEERING & FORGE CO.,
50, WELLINGTON STREET, GLASGOW. 6305

Oil Fuel Appliances.
SYSTEMS { PRESSURE. AIR. STEAM.
FOR BOILERS OF ALL TYPES.
Kermodes Limited,
35, THE TEMPLE, DALE STREET, LIVERPOOL; and
109, FENCHURCH STREET, LONDON. 4078
NAVAL OUTFITS A SPECIALTY.

Locomotives Tank Engines
designed and constructed by
MANNING, WARDLE AND COMPANY, LIMITED,
Boyne Engine Works, Leeds. Od 2437
See their Illus. Advertisement, page 119, last week.

Cochran Boilers.
MULTITUBULAR AND CROSS-TUBE TYPES.
See page 101. 6455

RAILWAY CARRIAGES, ELECTRIC CARS, &c.
Hurst, Nelson & Co., Ltd.
THE GLASGOW ROLLING STOCK AND PLANT WORKS,
MOTHERWELL. Od 3385

"Gripoly"
MACHINE BELTING
FOR
Driving
—
Conveying
—
Elevating
—
SOLE MANUFACTURERS
Lewis & Tylor, Ltd.,
CARDIFF. 6265
LONDON. MANCHESTER. GLASGOW.

New Chicago Automatics.
Three Sizes, Delivery from Stock.
NEW CAPSTANS, 1½ in. through the wire feed.
JOHN MACNAB, MANY STREET, HYDE.
Tel. No.: 78 Hyde. 6109

John Bellamy, Limited,
MILLWALL, LONDON, E. 1216
GENERAL CONSTRUCTIONAL ENGINEERS,
Boilers, Tanks & Mooring Buoys
STILLS, PETROL TANKS, AIR RECEIVERS, STEEL CHIMNEYS, RIVETED STEAM AND VENTILATING PIPES, HOPPERS, SPECIAL WORK, REPAIRS OF ALL KINDS.

Tubes, Iron and Steel.
Edwin Lewis & Sons, Ltd.,
Wolverhampton. 6408

Tubes and Fittings.
—
Stewarts and Lloyds, Ltd.,
Glasgow and Birmingham.
See Advertisement page 50. 6462

Rubber MANUFACTURERS
Belting
GUTTA PERCHA & RUBBER, LIMITED
Toronto - - Canada. 5918

CO^2 Plants (CARBON DI-OXIDE)
for Chemical & Mineral Water Mfrs. & Breweries.
READ & CAMPBELL, Ltd., 109, Victoria St., London, S.W. Telegrams—"Valorem, London."

CO^2 Fire Extincteurs
for Public and Private Bldgs., Electric Railways, &c.
THE BRITISH FIRE APPLIANCES Co., Ltd., 109, Victoria St., London, S.W. Telegrams—"Nonacid, London."

THE WELL-KNOWN
Fine Red Moulding Sand,
FOR
IRON, BRASS, ALUMINIUM.
APPLY,
Mansfield Sand Co., Ltd.,
MANSFIELD, NOTTS. 5175

Steam Generating Sets for SALE:—
One 200 Kw., Willans-Mather & Platt, 220 volts or 440 volts.
Two 375 Kw., Willans-Siemens, 460/550 volts, D.C.
Engines triple expansion.
One Electric Capstan, 31 B.HP., 500 volts, D.C. motor.
JENNINGS,
West Walls, Newcastle-on-Tyne. 6048

Builders of Locomotives,
HEAVY and LIGHT.
All Gauges and Types.
Address: Export Department,
H. K. PORTER CO.,
17, Battery Place, New York.
Or 3, London Wall Buildings,
London, England.
Cable Address—STAPELY, NEW YORK.
New Catalogue 19 A mailed on application.

R. Y. Pickering & Co., Ltd.,
(ESTABLISHED 1864.)
BUILDERS of RAILWAY CARRIAGES & WAGONS.
MAKERS of WHEELS and AXLES of all kinds.
RAILWAY WAGONS FOR HIRE.
Chief Works and Offices:
WISHAW, near GLASGOW.
London Office: 8363
3, VICTORIA STREET, WESTMINSTER, S.W.

Dredging Plant
OF ALL DESCRIPTIONS.
FLOATING CRANES. COAL BUNKERING VESSELS. 6069
Werf Conrad, HAARLEM, HOLLAND.
Agents: MARINE WORKS, LTD., FRIARS HOUSE, 39-41, NEW BROAD ST., LONDON, E.C.
See half-page Advertisement, last and next week.

Royles Limited,
ENGINEERS, IRLAM, MANCHESTER,
FEED WATER HEATERS,
CALORIFIERS, EVAPORATORS, } Row's
CONDENSERS, AIR HEATERS, } Patents.
STEAM AND GAS KETTLES.
Merrill's Patent TWIN STRAINERS
for Pump Suctions.
SYPHONIA STEAM TRAPS, REDUCING VALVES.
High-class GUNMETAL STEAM FITTINGS.
WATER SOFTENING and FILTERING. 5732

Yarrow Patent
Water-tube Boilers.
6094
MESSRS. YARROW & CO., UNDERTAKE the PRESSING and MACHINING of the various parts of Yarrow Boilers, such as the Steam Drums, Water Pockets, and Superheaters for British and Foreign Firms not having the necessary facilities.
YARROW & CO., LTD., SCOTSTOUN, GLASGOW.

Matthew Paul & Co., Ltd.
LEVENFORD WORKS, **Dumbarton.** 6054
See Full Page Advt., page 79, Jan. 11.

Forgings.
Walter Somers & Co., Ltd.,
HALESOWEN. 5549

Gas Engines, Suction Plants,
Inspections, Tests and Reports. Expert advice.—E. J. DAVIS, M.I.Mech.E., Great Eastern Road, Stratford. Telephones: East 1350; Stratford 569. Tel.: Rapidising, London. 1794

Taylor & Challen Presses.
8195
TAYLOR & CHALLEN, LD., Engineers, BIRMINGHAM

Railway Switches and Crossings.
T. SUMMERSON & SONS, LIMITED,
DARLINGTON. 6389

Cement.—Maxted & Knott,
LTD., Consulting Cement Engineers, ADVISE GENERALLY on proposed Cement Schemes FOR ENGLAND AND ABROAD. ADVICE ONLY. Highest references. Established 1900.
Address, BURNETT AVENUE, HULL.
Cablegrams: "Energy, Hull." 6290

Coke, Gas and Oil Fired
FURNACES. 4540
MONOMETER MANUFACTURING CO., LTD.,
ASTON, BIRMINGHAM.
See Advertisement page 60, Jan. 18.

Improved High Pressure
RENEWABLE DISC GLOBE VALVE.
See our Advertisement in last week's issue, page 20.
BRITISH STEAM SPECIALITIES, LTD.,
Bedford Street, Leicester. 3020

Head, Wrightson & Co.,
LIMITED.
See Advertisement page 27, Jan. 18. 2402

CHANTIERS & ATELIERS
Augustin - Normand
67, rue de Perrey—LE HAVRE
(France.)
2690
Destroyers, Torpedo Boats, Yachts and Fast Boats. Submarine and Submersible Boats.
NORMAND'S Patent Water-tube Boilers, Coal or Oil Heating. Diesel Oil Engines.

Centrifugals.
—
Pott, Cassels & Williamson,
MOTHERWELL, SCOTLAND.
6346
See half-page Advertisement page 82, Jan. 25.

The Manchester Steam Users' Association.

For the Prevention of Steam Boiler Explosions and for the Attainment of Economy in the Application of Steam. 9, Mount Street, Manchester.

Chief Engineer: C. E. Stromeyer, M.I.C.E.

Founded 1854 by Sir William Fairbairn.

Certificates of Safety issued under the Factory and Workshops Act, 1901. Compensation for Damages and Liabilities paid in case of Explosions. Engines and Boilers inspected during construction. 5884

Organization of British Industry.

Attention is continually being called by Government Departments and others to the urgent necessity of improving the organization of British industry.

With this object in view the Federation of British Industries has appointed a Committee consisting of Sir William Peat, Sir Francis Barker, and Mr. H. Fitzjohn Oldham, to give any advice and assistance which may be required by any trade which is considering the question of its organization.

This Committee will be ready at any time to consider any enquiries, or to render any assistance or advice either by correspondence or personal discussion with representatives of any such trade.

Letters should be addressed to the

Director of the Federation of British Industries, 39, St. James's Street, London, S.W. 1. K 245

Inst. C.E., I. Mech E., B.Sc.,

and all Engineering Examinations.—Mr. G. P. Knowles, B.Sc., Assoc. M. Inst. C.E., F.S.I., M.R.San.I., prepares candidates personally or by correspondence. Hundreds of successes. Courses may commence at any time.—39, Victoria St., Westminster, S.W. 6336

TENDERS.

Re Vixol, Limited.

By Order of B. D. Holroyd, Esq., the Controller appointed by the Board of Trade, Messrs. Fuller, Horsey, Sons & Cassell are instructed to invite

Tenders for the Purchase of

lots of the undermentioned

PLANT & MACHINERY

viz., Cylindrical Still with Lead Condenser, Cast Iron Condenser Tank, Three Jacketted Boiling Pans, Experimental Filter Press, Rotary Pump, 5 in. Screw Cutting Lathe, by Pfeil, Treadle Lathe, Watchmaker's Bench Lathe, Three Fly Presses, Benches and Fittings and other Effects.

Tenders to be delivered by Twelve noon on Thursday, February 14th, at the offices of the Auctioneers, 133, High Holborn, W.C. 1.

Catalogues and Forms of Tender, when ready, may be had of Fuller, Horsey & Co., 133, High Holborn, W.C. 1 K 240

Re the Tandem Smelting Company, Ltd.

By Order of B. D. Holroyd, Esq., F.C.A., the Controller appointed by the Board of Trade, Messrs. Fuller, Horsey, Sons & Cassell, are instructed to invite

Tenders for the Purchase of

the undermentioned:—

VALUABLE LETTERS PATENT

granted to Herbert Frederick Hoveler for improvements in

LIQUID FUEL BURNERS.

No. of Patent.	Date Granted.	Period.	Country.
105,112	Mar. 30, '16	14 yrs.	Great
6,644 '10	Mar. 16, '10	14 yrs.	Britain and
21,875 '07	Sept. 20, '07	14 yrs.	Ireland.

The Burners may, by permission of the Occupiers, be seen in operation at the Tandem Smelting Works, Merton Abbey, on Steam Boilers and Smelting Furnaces, and every opportunity will be afforded intending purchasers to satisfy themselves as to the merits claimed by the Patentee. There will be included in the purchase, the

STOCK OF BURNERS,

Spare Parts and Accessories, now stored at the Merton Abbey Works.

Tenders, which must be in the form contained in the Particulars, should be delivered under seal marked "Tender for Burner Patents," at the Offices of the Controller, B. D. Holroyd, Esq., F.C.A., 6, Great Winchester Street, by Twelve o'clock noon, on Monday, February 25th, 1918.

Particulars of the Patents, with Conditions of Sale and the opinion of Mr. A. J. Walker, K.C., thereon, may be had when ready of Messrs. Holroyd, West & Northcott, Chartered Accountants, 6, Great Winchester Street, E.C. 2, of Messrs. Mawby, Mawby & Morris, Solicitors, 6 & 7, Queen Street, Cheapside, E.C. 4, or of Messrs. Fuller, Horsey & Co., 133, High Holborn, W.C. 1. K 241

APPOINTMENTS OPEN.

PORTSMOUTH MUNICIPAL COLLEGE.

Principal: Oliver Freeman, Wh.Sc., A.R.C.S., B.Sc.

ELECTRICAL ENGINEERING AND PHYSICS DEPARTMENT.

Applications are Invited for

Immediate Appointment of Senior Lecturer in Electrical Engineering. Applicant must be ineligible for Military service.

Salary £300–£350, by £10 annual increment.

Forms of application and further particulars may be obtained on forwarding stamped foolscap envelope to the undersigned.

WANTED, Immediately, WORKSHOP INSTRUCTOR in Electrical Engineering, competent to instruct in Lathe and other Machine work. Must be ineligible for Military service.

H. E. CURTIS, Secretary. K 188

Analytical and Metallurgical

CHEMIST REQUIRED, to take charge of Laboratory and Heat Treatment Plant. Experience in handling of high-grade tool and automobile steels desirable. Birmingham district. No one already employed on Government work need apply. —Apply to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and K 242.

Analytical Chemist Required

for Foundry and Engineering Works in Midlands. Work comprising analyses of various materials and fuels used.—Apply by letter, stating age, previous experience, and salary required, to BULLERS Ltd., Tipton, Staffs. K 142

Wanted, in Government

Factory, METALLURGICAL CHEMIST, able to control pyrometers, including standardisation and up-keep, with thorough knowledge of photo-micrography of steel and non-ferrous alloys and general routine of metallurgy. No person already engaged on Government work need apply.—Apply your nearest EMPLOYMENT EXCHANGE, quoting No. A 4333. K 187

General Works Chemist; also

a CHEMIST with Micro-metallographic experience for work in connection with Aero and Motor construction. No one already on Government work will be engaged.—Reply, stating experience, age, salary expected, to LABOUR DEPARTMENT, Austin Motor Co., Ltd., Longbridge Works, Northfield, Birmingham. K 172

Required, by High-class Firm

of Motor Car and Aero Engine Manufacturers, a competent ENGINEERING LECTURER, B.Sc. in Engineering preferred. Would be required to lecture apprentices and lady students, conduct periodical examinations, and be responsible for keeping all records of apprentices' and students' progress, both practically and technically, in terms of a specifically laid down syllabus. No person already employed on Government work will be engaged.—Apply nearest EMPLOYMENT EXCHANGE, mentioning No. A 4487. K 123

Correspondence Clerks.—

Several first-class men REQUIRED for large Engineering Firm. Must be used to engineering terms and accustomed to draft and dictate letters. Shorthand essential. No one on Government work should apply.—Apply, giving full particulars of qualifications, experience and salary required, to your nearest EMPLOYMENT EXCHANGE, quoting No. A 4519. K 197

Wanted, Works Manager, for

growing concern in North Midlands area, Manufacturers, Constructional Engineers, Gas Plant, Sheet Metal Work, &c., employing about 70 hands. Thoroughly practical man required, to take live interest in business. Six o'clock man essential. First-class salary paid to first-class man; possible view to Directorship. This is a genuine application to infuse new blood into a prosperous concern of which the senior principal is desirous of additional help. Send full details of past experience, salary required, the whole of which will be treated in the strictest of confidence.—Address, K 200, Offices of Engineering.

Wanted, as Works Manager,

a PRODUCTION ENGINEER, with ability and initiative, for machine tool works. To a really capable man the situation offers good prospects. No person already on Government work will be engaged.—Apply your nearest EMPLOYMENT EXCHANGE, mentioning No. A 4464 and this Journal. K 189

Wanted, a Superintendent of

BOX REPAIR, to take charge large shop repairing Q.F. Ammunition Boxes. Man with engineering training preferred, but must be thoroughly capable organiser, used control and direction large output by female workers. No person resident more than ten miles away or already engaged on Government work will be engaged.—State age, experience, salary required and enclose copies testimonials, to BOX No. 314, Caxton Advertising Agency, Clun House, Surrey Street, Strand, W.C. 2. K 183

Wanted, Chief Engineer, for

Factory engaged on War Work. Must be competent to take full charge maintenance of plant, comprising steam gas (producers), electrical, machine tools, millwrighting and general machinery connected with factory. No person resident more than ten miles away or already engaged on Government work will be engaged.—State age, experience, salary required and enclose copies of testimonials, to BOX No. 313, Caxton Advertising Agency, Clun House, Surrey Street, Strand, W.C. 2. K 184

Wanted, by the Northwich

Electric Supply Co., Ltd. (vacancy due to death), an ENGINEER and SECRETARY. Must be exempt from Military service—Apply immediately, stating experience and salary required, to the CHAIRMAN, Northwich Electric Supply Co., Ltd., Northwich. K 117

Chemical Engineer.—Wanted,

by a Controlled Firm in Lancashire, a thoroughly experienced and efficient WORKS MANAGER and ENGINEER, accustomed to the control and supervision of men, and the keeping of detailed working costs. Sound general knowledge of chemistry and electricity essential, but must be of undoubted engineering ability, practical and theoretical.—State, in strict confidence, age, experience and salary required, to BOX L 827, Lee & Nightingale, Liverpool. K 48

Electrical Engineer Required

by large engineering company in London handling several mechanical appliances requiring electrical plant, and who intend to centralise all electrical work under one head.

Applications invited from those possessing College and practical experience, and fully competent to decide on design and lay-out of electric plant, Generating, every kind of motor service, transformer installations.

State age, full particulars and salary required.—Address, K 192, Offices of Engineering.

Required, the Services of an

ENGINEER to design and superintend the construction of a small hydraulic press.—X Box, 977, care of Judds, 97, Gresham Street, E.C. 2. K 212

Wanted, Assistant Mecha-

NICAL ENGINEER for South Wales, accustomed to hydraulic work and control of men. Salary about £350. Age not to exceed 45 years. Must be ineligible for Military service.—Address, with full details and references, K 50, Offices of Engineering.

NORTHAMPTON POLYTECHNIC INSTITUTE, CLERKENWELL, LONDON, E.C. 1.

Wanted, at Once, an Assistant

LECTURER and DEMONSTRATOR in the CIVIL and MECHANICAL ENGINEERING DEPARTMENT, with thorough practical and theoretical training in Mechanical Engineering. The salary will depend upon training and experience, and the salary expected should be stated. For forms of application, conditions of appointment and particulars of duties, apply to—

R. MULLINEUX WALMSLEY, D.Sc., Principal. K 230

THE SECRETARY OF STATE FOR INDIAN COUNCIL will, in 1918,

Appoint Three Natives

of India, if found qualified, as ASSISTANT ENGINEERS in the Indian Public Works and State Railway Departments.

Candidates must be eligible under Clause 5 of the Regulations and, save as provided in Clause 3 of the Regulations, must be not less than 21 and not more than 24 years of age on 1st July, 1918. They must either have obtained one of the certain recognised University degrees or other distinctions in Engineering, or have passed the Associate Membership Examination of the Institution of Civil Engineers.

Applications must reach the India Office by 31st March, 1918. Printed forms, together with information regarding the conditions of appointment, may be obtained from the SECRETARY, Public Works Department, India Office, Whitehall, London, S.W.1.

India Office, London.

5th December, 1917. J 801

Advertising.—Required, for

Engineers' offices in London, a MAN, to Take Charge of all Advertising Work, including literary contributions, &c. Discharged or otherwise exempt from military service.

One with technical knowledge, energy and ideas suitable for advertising the larger classes of machinery.

Write fully, stating age, complete details and salary required.—Address, K 193, Offices of Engineering.

Wanted, Superintendent for

Crucible Steel Foundry making small castings, of which many are intricate in shape. Must be thoroughly experienced in modern hand and machine moulding as well as in general foundry practice. To take charge of about 60 men. No person already on Government work will be engaged. Apply your nearest EMPLOYMENT EXCHANGE, mentioning No. A 4532. K 205

Engineer, First-class Man,

with good practical experience, REQUIRED by controlled steel works. Must have good working knowledge of steam and electric power plant, both A.C. and D.C., of the most modern type. Experience of rolling mills and wire-drawing plant very desirable. No person already on Government work will be engaged.—Apply your nearest EMPLOYMENT EXCHANGE, mentioning No. A 4551. K 233

Works Manager and Chemical

ENGINEER, with scientific training, REQUIRED. Must have a wide practical experience in carbonisation of coal and recovery of by-products. Unique opportunity for one with initiative and energy. Excellent prospects. State salary, age and experience and when available.—Address, K 225, Offices of Engineering.

Works Manager Wanted, for

permanent position in established engineering works manufacturing a speciality. Should be well trained in the most modern and up-to-date methods in turning and grinding operations, working to very fine limits. Good opportunity for a progressive man capable of taking responsibility. State full particulars of education, experience and salary required.—Address, K 239, Offices of Engineering.

Works' Superintendent

WANTED for the fitting, erection and machine shops of controlled engineering works, 500 hands, in Lancashire. All-round capable engineer required, with previous managing experience, and possessing necessary initiative and tact to get best out of foremen and workmen. No one already on Government work will be engaged.—State age, experience, references, salary required, to nearest LABOUR EXCHANGE, mentioning this Journal and K 226.

THE NATIONAL FOREMAN'S ASSOCIATION. ENGINEERING, SHIPBUILDING & ALLIED TRADES.

Applications are Invited for

the POSITION of ORGANISING SECRETARY for the above Association from gentlemen having Engineering and Organising experience. Applicants must be prepared to devote whole time to the business of the Association, whose headquarters will be in London.—Applications to be forwarded not later than 31st January to H. E. BUTCHER, 273, New Cross Road, S.E. 14, with copies of testimonials, stating age, experience and salary required. K 208

Required, Three Cost Clerks.

—Apply, NORTON-GRIFFITHS, 3, Central Buildings, Westminster, S.W. 1. K 227

Chief Draughtsman Required

immediately for large Aircraft Factory in Lancashire. Thorough experience of aircraft design essential. No person already engaged on Government work will be engaged.—Apply, giving full particulars, to your nearest EMPLOYMENT EXCHANGE, mentioning this paper and No. A 4477. K 220

Electrical Draughtsmen Re-

QUIRED, used to ship work. Apply, giving experience, age and salary required. No one already employed on Government work engaged.—Apply to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and K 209.

Wanted, Immediately, a

reliable and good DRAUGHTSMAN, accustomed to preparing drawings for graving docks and harbour works.—Address, K 191, Offices of Engineering.

Draughtsman Wanted, with

experience in steam plant and general engineering. Permanency and good prospects. State age, salary and full details of experience.—K 235, Offices of Engineering.

Draughtsmen, Aeroplane and

Jig and Tool, REQUIRED for large Aeroplane Factory in the North. No person already engaged on Government work will be engaged.—Apply, giving full particulars to your nearest EMPLOYMENT EXCHANGE, mentioning this paper and No. A 4478. K 219

Draughtsman Required with

general mechanical engineering experience. Applicants to state qualifications, with two copies of recent testimonials, age, salary required, and whether married or single. No person already on Government work will be engaged.—Apply to your nearest EMPLOYMENT EXCHANGE, mentioning the name of this Journal and No. A. 4457. K 87

Draughtsman Wanted by a

large Controlled Engineering Works, within a hundred miles of London; age about 30, with good mechanical engineering training; up-to-date experience, Portable and Traction Steam Engines and Boilers essential. No person already engaged on Government work will be engaged.—Address, stating fully age, experience and salary required, to your nearest EMPLOYMENT EXCHANGE, quoting No. A 4435 and this Journal. K 85

Draughtsman Wanted, with

first-class Mechanical Engineering experience. Some knowledge of Lifting Machinery an advantage. Apply to your nearest EMPLOYMENT EXCHANGE, stating age, experience and salary required, mentioning No. A 4435. No person already engaged on Government work need apply. K 63

Draughtsmen Wanted, for

London. Must have had works experience, accustomed to light structural steel, engine or heavy motor traction work.—Write in first instance, stating age, salary expected and briefly qualifications, experience and position regarding military service.—Address, THE COMMISSIONER, Ordnance Department, U.S.R., 123, Pall Mall, S.W. 1. Mark envelope "Draughtsman." K 206

Draughtsmen with General

Engineering experience. Several REQUIRED immediately for Controlled Factory. Give details of previous work, salary required, and when at liberty. No person already on Government work will be engaged.—Apply, your nearest EMPLOYMENT EXCHANGE, mentioning No. A 4396. K 175

Jig and Tool Draughtsman

WANTED, immediately, for Government controlled establishment situated in Eastern Counties. Applicants must have had good experience. Progressive position for right man.—Apply, stating age, experience and salary required, to nearest EMPLOYMENT EXCHANGE, mentioning this Journal and K 209. No one already on Government work can be engaged.

Draughtsmen (Mechanical),

preferably with shop experience, REQUIRED for work on Government contracts. No one already engaged on Government work or residing more than 10 miles away will be engaged.—Apply, stating full particulars, experience and salary required, to K 250, Offices of Engineering.

Mechanical Draughtsmen

WANTED, for large Engineering Works in Lancashire, conversant with Turbo Station layouts, also design of surface and jet condensing plant.—Apply, stating age, experience, and salary required, to your nearest EMPLOYMENT EXCHANGE, mentioning No. A 4512. K 176

First-class Draughtsmen

with good general experience WANTED by large Controlled Firm in South Yorkshire.—Address, giving full particulars of experience, and salary required (inclusive of War Bonus), J 348, Offices of Engineering J 348

Senior Draughtsman Wanted,

for Aeroplane Works. Good position vacant for man of first-class capabilities and experience.—Apply, stating age, training, experience and salary required, to nearest EMPLOYMENT EXCHANGE, mentioning this Journal and K 210. No one already on Government work can be engaged.

Several First-class Mechanical

or Aeronautical DRAUGHTSMEN, with workshop experience and technical training, are REQUIRED immediately by well-known firm in London. Ordinary working hours, 46½. Overtime paid, and good War Bonus. No one employed on Government work should apply.—Apply, giving full particulars of training, subsequent experience, qualifications and salary required, to your nearest EMPLOYMENT EXCHANGE, quoting No. A 4518. K 186

Draughtsman Required for

Iron and Steel Works in the Midlands. Must be thoroughly accustomed to this class of engineering. No one already on Government work will be engaged.—Apply, stating experience, testimonials, when at liberty and salary expected, to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and K 78.

Draughtsmen Required

willing to take up Electrical Apparatus Work, with large firm of cable manufacturers. Please state age, experience and salary required. No person residing more than ten miles away or already employed on Government work will be engaged.—W. T. HENLEY'S TELEGRAPH WORKS COMPANY, Ltd., 14, Blomfield Street, E.C. 2. K 131

Draughtsman Wanted for

Blast Furnace Plant in the Midlands. Must be thoroughly accustomed to this class of work and competent to getting out working drawings of furnaces, stoves, tubing and other engineering work in connection therewith. No one already on Government work will be engaged.—Apply, stating experience, testimonials, when at liberty and salary required, your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and K 77.

Draughtsmen, One or Two,

REQUIRED, by Engineers in City. Those with workshop experience preferred. No one resident more than ten miles away or employed on Government work will be engaged. Apply, stating age, experience and salary required.—Address, K 222, Offices of Engineering.

THE SETTING OF CEMENT AND PLASTERS.

(*Concluded from page* 73.)

WE now complete our notice of the general discussion of the problems of cement-setting held by the Faraday Society on Monday, January 14th.

The important contribution on "*The Setting and Hardening of Portland Cement*" by Mr. G. A. Rankin, of the Geophysical Laboratory, Carnegie Institution, Washington, would justify a longer notice if it were less chemical in nature. In American Portland cements, Mr. Rankin stated, they had found about 90 per cent. of the three main constituents, lime, alumina, silica, the rest being magnesia and ferric oxide. A perfectly burned clinker consisted essentially of the dicalcic silicate $2\,CaO.Si_2U_2$ (A), the tricalcic silicate $3\,CaO.SiO_2$ (B), and the tricalcic aluminate $3CaO.Al_2O_3$ (C); with incomplete burning the aluminate $5CaO.3Al_2O_3$ (D) and free lime were further found. The A seemed first to be formed, but taking up more lime, A passed into B, which was the essential compound, though slowly formed with difficulty at high temperature. Of the aluminates D was first formed, C following later, and C was generally found alone in the finished product (without D), but its presence did not appear to be essential; nor were the magnesia and iron oxide. On hydration, the Ca O first turned into amorphous calcic hydrate, which subsequently crystallised as lime hydrate; when free lime occurred in the cement, it had been high-burned and might cause disintegration, as the cement hardened. The D compound set and hardened rapidly in presence of 30 per cent. of water, but moulded specimens placed in hot or cold water disintegrated, partly because the D dissolved and dissociated; a hydrate of C, amorphous first, seemed to form. The C compound itself set in water, but remained rather soft; the resulting amorphous material crystallised completely. The A compound reacted very slowly with water, and it took months before a moulded specimen became strong though it remained sound. Under the microscope the formation of an amorphous material was observed, which did not crystallise as such, however, while crystals of lime hydrate appeared. This amorphous growth was accelerated by the presence of the aluminate C which increased the solubility of A. The tricalcic silicate B finally set and hardened rapidly when mixed with water; an amorphous compound was again formed, more rapidly than in the case A, and more lime was leached out; the other constituents of the cement did not affect these reactions. The conclusion drawn was that the initial set of Portland cement was due to the aluminate C; that the hardening was due to the formation of amorphous material forms C and B which crystallised, and that the gradual increase in strength was due to the further hydration of these compounds and of A.

Vicat's theoretical cement and the tricalcic silicate B were very similar in their behaviour, Mr. Rankin continued. They both released amorphous (gelatinous) silica when treated with water, and it was interesting to note that the toughest sandstones known were made up of grains of sand cemented together with gelatinous silica, which was gradually deposited from the solution on the grains and subsequently hardened. Thus gelatinous silica seemed to be the most essential constituent of cement, though that conclusion was somewhat speculative. To increase the percentage of the gelatinous silica, the percentage of compound B in the clinker should be increased. Now, this tricalcic silicate in its pure condition—Rankin does not appear to have isolated the pure homogeneous compound—seemed to be formed at 1,700 deg. C., which was too high a temperature technically; a flux had to be added, and the iron oxide and magnesia supplied the flux. The percentage of those two minor constituents in clinker might safely be increased to 7 or 8; the iron cements in particular were useful, as they resisted sea water better than ordinary Portland cement, owing, probably, to some combination between the iron oxide and calcium aluminate; the D compound burned with iron oxide gave a clinker which ground and mixed with water was sound and strong. A direct increase of the percentage of the compound B in the cement did not appear to be commercially possible, but silica might be released from A, not only by the aid of the aluminate C (as mentioned), but by the aid of some other electrolyte.

The other contribution from the United States was not less important, but still more chemical. It was by Mr. A. A. Klein, formerly of the Bureau of Standards, now of the Norton Company, of Worcester, Mass., on "*The Constitution and Hydration of Portland Cement.*" Having pointed out that neither Tornebohm nor Le Chatelier had in their early simultaneous researches been clear as to the chemical nature of the products, and that too much reliance had been placed on petrographic examination, Mr. Klein stated that Portland cement was obtained by a sintering process followed by quick cooling, to prevent dusting of the clinker. Under these conditions only minute crystals would be formed, which would overlap in the thin sections and could not be distinguished by rough methods. Optically, tricalcium silicate and tricalcium aluminate differed very little. Using the optical methods of the Geophysical Laboratory, however, the Bureau of Standards had verified most of the predictions of the former as to the composition limits of Portland cement. The Bureau had extended the research, investigating five possible combinations of lime, silicates and aluminates, three of which were found never to occur in cements. Iron oxide partly coloured the $2CaO.SiO_2$, though the reaction was not fully understood, and partly formed flux material, varying from opaque to black, which might be sufficiently reduced to show magnetic properties. Magnesia would replace part of the lime in the silicates and aluminates; in properly burned cement 7 per cent. to 8 per cent. of MgO might be tolerated. Mr. Klein then passed to the hydration of the possible combinations of lime, silica and alumina, which they had synthetised at the Bureau, when treated with water, steam and also with solutions of lime and of gypsum. The main conclusions drawn—which somewhat differ from Rankin's—were that the hydration of cement was brought about by the formation of amorphous hydrated tricalcium aluminate, with or without amorphous alumina, the aluminate later crystallising; at the same time sulpho-aluminate ($3CaO.\,Al_2O_3.\,3CaSO_4.\,x\,HO_2$) made its appearance, and low-burned or finely-ground lime was hydrated. These reactions occurred soon after gauging. Within 24 hours the tricalcium silicate B began to hydrate, and the early strength was due to these reactions. Later (after one to four weeks) the amorphous aluminate crystallised and beta-calcium orthosilicate began to hydrate; high-burned limes lost strength in this period. Though more resistant chemically to solvents than B, the silicate A hydrated slowly to a very granular mass, which was mechanically weak and furnished voids in which other salts could crystallise. The gelatinous colloidal silicate from C had a very dense structure, and was very susceptible to strains produced by alternate wetting and drying, because colloidal matter was subject to volume changes with moisture changes. Thus neither silicate should preponderate, though an excess of the disilicate A was desirable for gaining strength at later periods. The function of the tricalcium aluminate was somewhat problematical. A Portland cement need, perhaps, not contain more than 1 per cent. of alumina, but such a cement could not be manufactured commercially at a reasonably low temperature.

Speaking on the "*Setting of Cement in its Relation to Engineering Structures*," Mr. Bertram Blount regretted the elasticity of the terms cement and setting. There was no definite proof to show that the constituents of Portland cement formed supersaturated solutions, as in the case of plaster of Paris, and there was no conclusive evidence in favour of either the crystalline or the colloidal view of setting. Setting was a gradual process, and there was in reality no such thing as setting point or setting time. About 1887 Professor John Goodman had filled a trough with the cement to be tested, and pulled a roller, provided with a central pin to dip into the cement, along the trough edges by clockwork, a pencil automatically recording the rate and time of setting. It was a neat idea, but there was no definite point of time when the pin ceased to make an impression. In practice the Vicat needle had alone proved of use for determining the setting time. But the needle tested the cement neat, though it was scarcely ever used neat, the sand and stones added were mechanically in the way of progressive hydration and, what was much more important, influenced the thermal effect. It had, indeed, been suggested, chiefly in Germany, to measure the rise of temperature as a mode of determining the setting time; "anything more lunatic is difficult to conceive." When the cement was slow-setting, and the proportion of aggregate was considerable (6 or 8 to 1, as it was usually), the rise of temperature was not large, unless the cement were so unsound that it contained what was conveniently termed "free lime"; but with a high temperature the rate of setting might be too high for satisfactory construction. The cement manufacturer had to be proleptic as he had to provide cement that would answer in tropical summers as well as in Canadian winters, and the difficulties increased in the case of ferro-concrete. A 30-ton block for harbour work might be in the yard for six months, and if it did not set hard at once, no one was much the worse, provided cement and aggregate were of good quality. With ferro-concrete a reasonable time must be allowed for such things as piles, as they were not put to use immediately and might lie in the yard; but the ordinary ferro-concrete structure was monolithic, and the engineer responsible for the structure must know the period necessary for proper setting. Mr. Blount's paper did not contain any further references to engineering structures.

Mr. John G. A. Rhodin, F.I.C., raised the question "*Is the Setting of Cement mainly a Physical or a Chemical Process*," starting in his remarks from experiments he had made to recover the potash contained in orthoclas. He had years ago tried to convert the potash into KCl by heating, to 900 deg. C., 100 parts of finely-divided feldspar with 40 parts of dry slaked lime and 40 parts of NaCl; finding that water played an important part in the reactions he had passed steam into the muffles. The residue left after washing the alkali salts out of the mass, was a silicate of lime and alumina which behaved like a zeolite; it was soluble in acid, capable of hydration, hardened slowly like an imperfect cement, and could be converted into a good cement by heating with more lime. Zeolites, moreover, lost their water and turned dull when heated, but changed into translucent crystals again when immersed in water; Mr. Rhodin's white cement from feldspar had under similar conditions suddenly changed into a mass of translucent crystals when watched with the microscope. A condition of labile molecular equilibrium was common to all cements. He had prepared a blast-furnace slag cement (with the aid of lime and salt) which completely lost its cementing properties when stored in a stoppered bottle for 24 hours, turning from a quick-setting cement into an inert powder. When, however, a little (0.5 per cent.) of alum or aluminium sulphate was added to this preparation before firing, the cement kept well, he could not say for what reason. The molecules of a cement seemed to be in a state of tension, ready to break up into smaller centres, the rate being diminished by the presence of certain substances; the change of colloids into crystalloids was probably a similar phenomenon.

Messrs. E. Deny, of Ghent, and E. H. Lewis, M.A., contributed notes on "*The Effect of Adding Suitable Slags on the Setting Properties of Portland Cement.*" Confirming, so far as their experiments in this country went, Dr. Passow (Hochofenschlacke in der Zementindustrie), they stated that they had used a slag from hematite pig furnaces (about 40 per cent. of lime, 31 per cent. of silica, 15 per cent. of alumina) rich as usual in lime. Mixing this slag in the usual fashion with limestone and clay, they had obtained a product resembling Portland, the lime and clay of which had, however, been burned twice, the first time in the furnace. Such cements were quick-setting, but that property could be modified by the use of suitable limestone and the addition of granulated slag; the latter addition, they found, also increased the tensile strength, though the addition of slag to the clinker in the finishing mills

was sometimes objected to. The tensile strengths given, averages of more than 1,700 tensile tests, were 570 (and 855) lb. per sq. in. after three (and 28) days. The granulated slag had itself well-marked setting properties. Bricks made of this slag gave after three days, seven days, and six months, strengths of 195, 300, 615 lb. per sq. in., when stored in air (the strength fluctuating later), and after seven days and three months strengths of 215 and 400 lb. per sq. in., stored in water; the briquettes consisted of 1 part of the slag, three parts of sand, and 8½ per cent. of water. Messrs. Deny and Lewis also tested their cement, either neat or further mixed with Wishaw blast-furnace slag (ratio 70 to 30), and found that the setting time (initial and final) was increased by the slag addition (from 6 and 8 minutes to 16½ and 70 minutes), the expansion was reduced (Le Chatelier test), and the tensile strength increased (from 560 to 630 lb. per sq. in. after seven days). Similar experiments with four brands of cement from England and South Wales had yielded equally satisfactory results. It was true that quick-setting Portland cements were apt to lose strength in the course of time; with the high alumina percentage in their cement, however, they could use a clinker containing more lime than usual without fear of expansion. Their ground clinker was quick setting, as stated, but the addition of a suitable slag delayed the setting; in one case they had obtained a strength of 1,300 lb. per sq. in. after 28 days. Theoretically they agreed with W. Michaelis. Messrs. Deny and Lewis did not give analyses of their products.

In his contribution on "*Ancient and Modern Cements*" Mr. W. J. Dibdin, F.I.C., gave a summary of an investigation which he had been conducting, chiefly in the period 1907 to 1910, on behalf of the Science Committee of the Royal Institute of British Architects. The investigation, Mr. Dibdin stated, did not bear out the belief that ancient mortars were stronger than modern mortars could be made, and that methods of the art had been lost. As regards the preparations of lime and aggregate, sand, clay, &c. many statements were indefinite as to the condition of lime. One cubic foot of unslaked lime had, on slaking, occupied 1.4, 1.7, or more cubic feet in different tests, when slaked, and he had therefore calculated all his figures as to CaO and volume relations. The proportion of aggregate (lime = 1) in ancient mortars he found to vary from 0.4 to 3.7, the average being about 1, whilst modern practice was 3. Mr. Dibdin's experiments were made mostly on the ratio 1 lime to 3 aggregate; he did not test the ratio 1 to 1. The aggregate might be clean washed sand, but in the old London Wall and in some buildings from the twelfth and thirteenth centuries ferruginous clay made up as much as 19.5 per cent. of the aggregate, whilst the Roman pharos at Dover consisted merely of lime and broken brick, and that of Threlfall Castle, near Hythe, of lime, flint and pebbles. Testing mortars from three different limes (white chalk lime, Dorking grey stone lime, blue lias lime) with five different aggregates (standard Leighton Buzzard sand, fine Charlton sand, pit sand, Thames sand, ground brick) in ratios of 1 to 2 or 3, he had obtained higher strengths with the mixtures richer in limes and of coarser grains; these figures indicated that the modern rush after economy, by reducing the quantity of lime, was largely responsible for the falling off in quality. The additions of 5 per cent. of clay gave, in 1:3 mixtures, poorer results except with the blue lias lime, where the strength was raised. In other cases, with five volumes of sand to one of lime, the addition of clay (up to 10 per cent.) decidedly increased the strength, which was very low in the mixture poor in lime. Large voids in the cement were found to decrease the strength. As regards soluble silica (or silicates) the Roman Wall contained only 0.3 per cent., in the old Crosby Hall 3.8 per cent. of soluble silica were found, and even higher figures had been obtained; in such cases, however, trass or pozzuola seemed to have been used, and Mr. Dibdin's own specimens contained no trace of soluble silica after twelve months.

The question of iron cements was the first raised during the general discussion. Mr. Percy C. H. West said that opinions as to the merits of iron cements had been divided in Germany since the 'eighties when these cements were manufactured on a large scale; the Materialprüfungsamt had not admitted that there had been a great improvement, and Mr. West himself did not consider that a good cement was improved by the addition of blast-furnace slag, though he did not wish to imply no iron cement was bad; the chief advantage was probably the reduction of cost. It was true that the slag admitted of preventing quick setting; but it also led to swelling, which in one case under his notice was sufficient to dislocate certain walls; he had tested the parts of this highly-sulphated cement and had proved that the fault was in the cement.

Dr. Desch, in his final reply, took a distinctly favourable view of the future of iron cements; the blast-furnace slag, he considered, acted like a volcanic earth in Roman cements, and was in fact a very active pozzolana, because half of it consisted of a glass whose silica was easily liberated. The subsequent expansion was the objection, but that depended upon the percentage of sulphur which could be regulated, and the way of its combination. The behaviour of the jetty of the Skinningrove Iron Works which had been exposed to sea water for thirty years, justified confidence in iron cement, made and laid with care, of course.

Mr. W. D. Caroe, speaking as an architect acting for the Ecclesiastical Commissioners, mentioned three recent instances in which scientific advice had been of the greatest value to architects. When they had inquired into the stability of St. Paul's Cathedral they had been troubled by the impression that Wren had placed too much reliance on brick and mortar, until Mr. Dibdin had shown them the superior character of Wren's mortar, which was far richer in lime than modern practise prescribed. The second instance was that of the buildings of the National Physical Laboratory; during these operations everything had been tested, showing them how much they had been groping in the dark. The third instance was that of Allington Castle (eleventh century) in which Mr. Dibdin had demonstrated the good influence of clay, which they had always excluded. Cement was the builder's most important, but also most dangerous material. It attacked certain stones, and he always refused to point buildings in cement where the cement would be exposed to the atmosphere. Of 2,500 cement slabs, placed in St. Paul's over cracks, 1,500 had cracked again; Mr. Horace Darwin had experimented on this point by filling grooves cut in the stone with cement. Slag cement, Mr. Caroe had found, might continue to expand for five years—we are not certain whether Mr. Caroe referred to slag cements or cements in general.

Mr. A. Binns dwelt on the difficulties the engineer had with concrete. He had had concrete removed because it would not set, and had afterwards observed that the concrete was sound. It was very difficult to get large masses of concrete homogeneous; once the concrete had been got into place, the contractor was anxious to get on with the stripping of his shuttering; the plane of the day's work—generally layers 3 ft. thick with shutters 6 ft. high—always remained a point of weakness at which percolation occurred. When Mr. Binns had blasted some concrete that had been under water for over thirty years it came out in square blocks. He had tested 1-in. cubes of concrete for percolation under a head of water of 35 ft.; the curve approached impermeability in less than ninety days. Another trouble was that, even with the best mixing machinery, the quantity of water added to the concrete varied by at least 33 per cent. When ferro-concrete was stripped off its reinforcement it was found that the iron was embedded in mortar; it was a perfect bed of mortar, stones nowhere touching the iron; in fact, Mr. Binns had dipped a pebble into the mortar and allowed it to set, and had found that the mortar had run up the pebble a considerable distance, as much as ¼ in.

Mr. W. J. Cooper, of Penarth, admitted that the manufacturer, user, and independent examiner often differed widely as to the setting time, and that this problem required further investigation; but a good Portland cement should certainly not expand.

Dr. M. T. Lowry, F.R.S., and Mr. F. C. Hennings after him, referred to the troubles of the caking of powdered materials which they had been investigating for the Department of Research. So-called powders of ammonium nitrate had had to be chiselled out of their barrels; copper sulphate and Rochelle salt (alkali tartrate) caked similarly, and a brass tube had become choked with an enamel of ground trinitrotoluene. The ammonium nitrate had three transition points, at 32 deg., 84 deg. and 124 deg. C. If dried below 32 deg. the powder remained loose, but it was not completely dry; if dried above 32 deg., it recrystallised on cooling and turned to stone; any mechanical work would tend to cake the salt. But if the crystals were reheated and shaken and turned over in a machine, instead of being kept quiet, the crystals broke down like quick lime. The essential thing for caking was the presence of a solvent; even partially-dehydrated $CaSO_4 . 5H_2O$ would remain granular in the absence of free water. In the case of potassium perchlorate some works had much been troubled with clogging until they had, on Dr. Lowry's suggestion, thoroughly dried the crystals before grinding them.

Dr. W. Rosenhain, F.R.S., further extended the analogy of the setting of cement and salts generally by referring to the setting of fused metals, and also to the welding of metals. Adhesion due to friction, and a strength of the textile tissue type as suggested by H. le Chatelier, might be dismissed, he thought; the crystalline particles of metals were held together by films of amorphous, undercooled metal, and those films were hard because they were not weakened in certain directions by cleavage and gliding planes.

Mr. E. Hatschek remarked that the two rival theories of Le Chatelier and Michaelis, the crystalline and colloidal, were really compatible and complementary. Criticising the inconsistency of Le Chatelier, he pointed out that even so pronouncedly crystalline a substance as barium sulphate had been obtained in the colloidal state, and organic chemistry knew many substances in which transition from one state into the other could distinctly be watched. Reactions in concentrated solutions gave jellies, and large crystals grew at the expense of smaller ones.

Dr. Desch summed up in the same sense. He admitted the analogy suggested by Dr. Rosenhain. But in metals, the films were probably layers of the original material; in the case of cements all the substances concerned were of low solubility, or formed unstable compounds of low solubility.

The special vote of thanks, passed to Dr. Desch for the remarkable lucidity of his exposition and of his final reply, which showed a perfect command of the facts, was fully deserved.

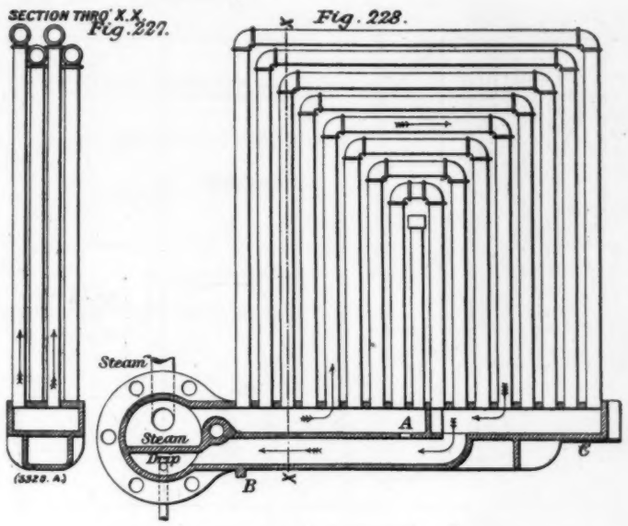
THE ARRANGEMENT OF MACHINE SHOPS.—No. XXIV.

By Joseph Horner.

The primary elements in the plenum system of ventilating and heating are the fan, the heater, and the distributing pipes. On the proper selection of the fan much of the efficiency of a ventilating installation depends; but sufficient data are now available to enable a proper choice to be made of the type suitable for given conditions. All the data which enable a suitable selection to be made for all conceivable conditions have been accumulated by the specialising firms, whose figures and recommendations should be adopted. Reliable tables are provided of fan capacities, suitable speeds, and horse powers corresponding. These have to be co-related to the character of the installation, which varies much in regard to the distances to which the air has to be propelled with consequent higher or lower velocities, and greater or lesser resistances in the ducts. For in all cases such tables are based upon the "free delivery" that is on the capacity of the fan as measured by an air meter at the outlet. At the farthest limits of the pipe system the delivery may be from 10 per cent. to 25 per cent. below the free delivery capacity. Heaters, pipes, and registers all set up resistances to the free passages of the air and the estimate of fan capacity has to be based with due allowance for the total friction losses which occur in the transmission elements.

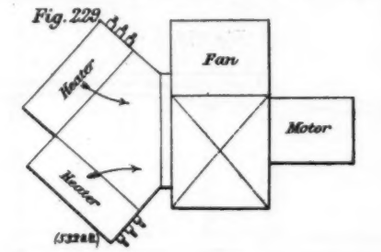
A heater is usually built up, as shown in Figs. 227 and 228, of units. Each unit, self-contained and complete comprises a base, and a series of

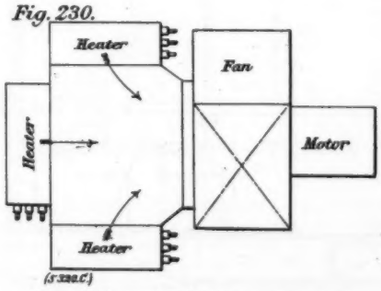
THE ARRANGEMENT OF MACHINE SHOPS· HEATING AND VENTILATING.



FIGS. 227 AND 228. A STURTEVANT HEATER UNIT.

FIG. 231. INSTALLATION OF FAN AND HEATER; THE STURTEVANT CO.





FIGS. 229 AND 230. DUPLICATE AND TRIPLICATE HEATERS.

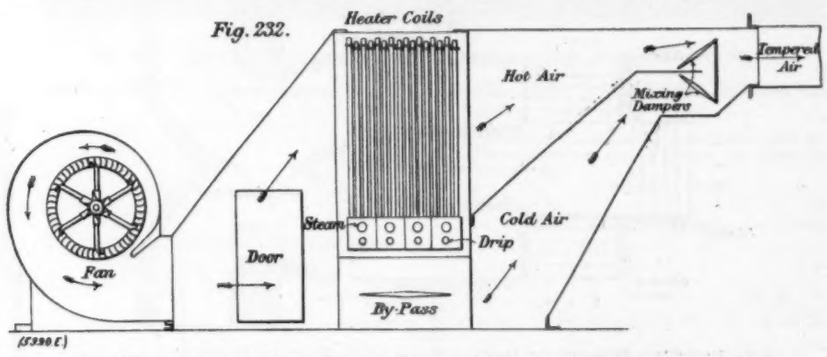


FIG. 232. INSTALLATION FOR MIXING HOT AND COLD AIR; THE STURTEVANT CO.

pipes. Steam is circulated through the pipes, and air being forced, or drawn through the interspaces becomes heated by the abstraction of heat from the steam, which condenses,

The basis of the estimation of heater efficiency is that of the quantity of air which can be warmed by the condensation of a given quantity of steam. The amount of heat which is required to raise the temperature of 1 lb. of water through 1 deg. F. will heat 4.2034 lb. of air through 1 deg. F. Exhaust steam, when available, can of course be used more economically than live steam, but for equal condensation exhaust steam requires a larger surface area in the heater than live steam does, because the rate of transmission of heat is proportional to the difference in temperature between the steam within and the air without the pipe. The supply pipe for exhaust steam must also be larger than one for live steam. Heaters will utilise supplies of both live and exhaust steam, if a reducing valve is provided for the former, and then the exhaust steam may be used during the day, and live steam at night. Very high velocities of air through heaters are objectionable because of the humming noise which results, and of the increased power that is required to drive the fan. With increase in the number of heater sections, velocities can be lessened. Suitable velocities for factories are from 1,500 ft. to 1,200 ft. per minute.

Heaters are built up in different patterns to supply all conceivable requirements. In the Sturtevant design, Figs, 227, 228, the standard size of pipe used is 1 in. spaced at 2½ in. centres, which gives a "free area" of about 5.5 per cent. of the heating surface in a standard four-row section. The pipes are of steel, tested at 180 lb. pressure. They can be worked regularly at 80 lb. They are thick enough to permit the cutting of threads without sacrifice of the necessary strength. The lower ends of the vertical series are screwed into cast iron headers. The vertical rows are united to the horizontal pipes with bends. The pipes are staggered in the headers, bringing those in one row behind the open spaces of the row adjacent, so compelling the air to take a circuitous path. The "free area" through the complete heaters—that is the inter-pipe spaces is about 40 per cent. of the total cross-sectional area of the heater. If it were much less, the resistance of the movement of the air would become excessive, and if much greater the efficiency is reduced. The sides of the headers are corrugated so that the units fit snugly against each other.

In Fig. 228 it is seen that a diaphragm separates the steam inlet passage from the exhaust in the steam supply pipe, and in the body of the header. Steam, entering the larger area of the pipe, passes along the portion of the header adjacent up into and around the coils, and descends into the exhaust pipe. The latter is provided with a drip outlet for the water of condensation, and there is also a small hole, A, in the partition, which passes condensed steam that may gather in the supply chamber, into the exhaust. Provision is made for expansion. The header is carried on an angle bar at the front end, which takes a bearing against a lug, B. A flat, C, at the other end is free to slide on an angle there.

From these independent sections, the heaters are built up with moderate increments of heating surface. The lengths of the pipes are made to suit head room available, ranging from 3 ft. to 6 ft. The sections are united through the flanges with gasket joints, and fastened with bolts that pass through all the flanges. Each section may be operated independently by the insertion of a blank flange, which is often done for the purpose of being able to use exhaust steam in some sections, live steam in others. Fig. 231 illustrates the relations of an engine-driven fan, and its heater, which is warmed by the exhaust steam from the engine. This, like the diagrams Figs. 229 and 230, which show duplicate and triplicate arrangements of heaters, is of the draw-through design. The flanges which unite the heater sections are seen beyond the fan, and their through-bolts. A steam trap for the water of condensation is seen between the fan and the heater.

In the draw-through system, which is suitable for use when the primary object of the system is heating, the exhauster type of fan is employed, having an inlet on one side only, and the heater is placed in a jacket connected to the inlet of the fan. The air is thus drawn through the heater coils on its way to the fan, which propels it to the distributing ducts, as shown in Figs. 229, 230. In the blow-through system the heater jacket is connected to the outlet of the fan, and the air is

THE ARRANGEMENT OF MACHINE SHOPS; HEATING AND VENTILATING.

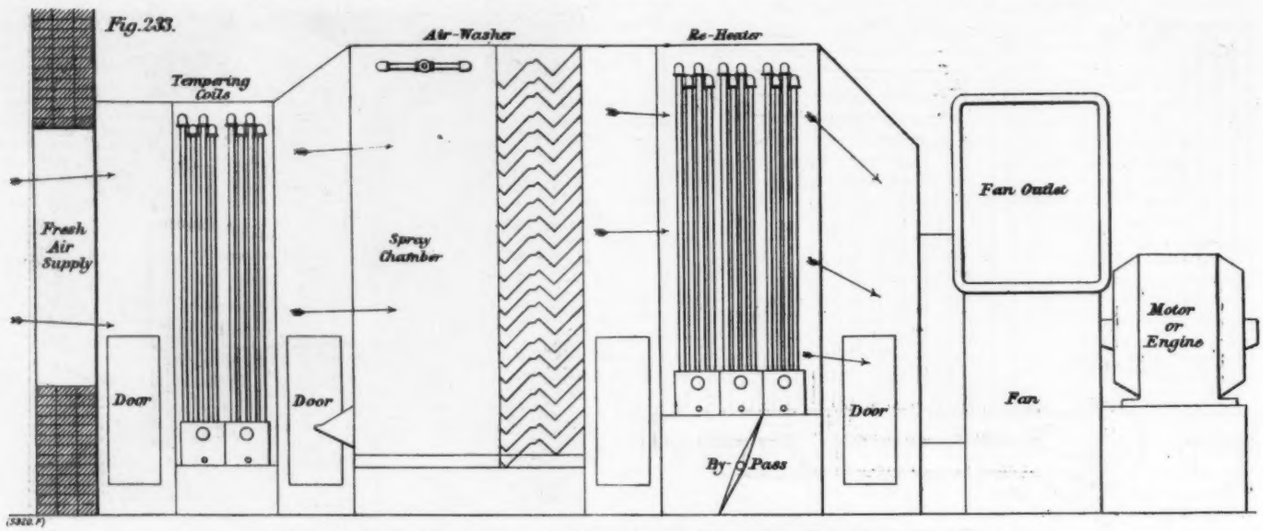


FIG. 233. INSTALLATION WITH AIR WASHER AND REHEATER; THE STURTEVANT CO.

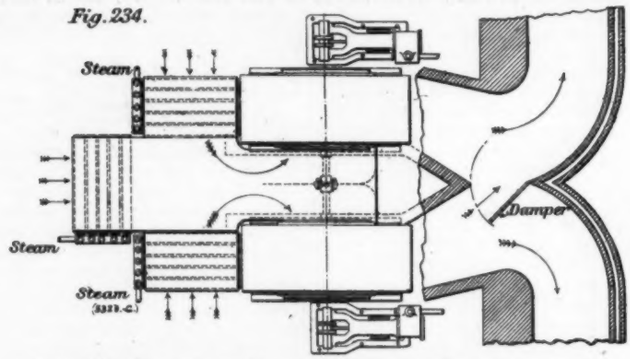


FIG. 234. DIAGRAM OF DOUBLE DISCHARGE; BUFFALO FORGE CO.

FIG. 235. DOUBLE DISCHARGE PIPE; THE STURTEVANT CO.

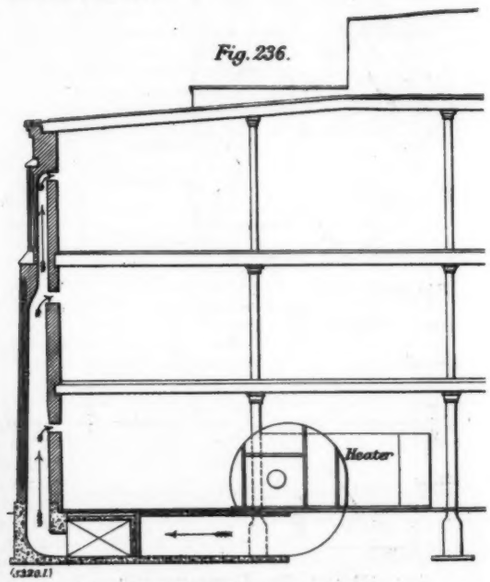


FIG. 236. DUCTS BUILT INTO WALLS; THE STURTEVANT CO.

forced by it through the heater. This method is adaptable when more than one temperature is desired, as in some storied buildings in which separate rooms may have to be dealt with differently. A by-Pass in the heater casing, and dampers are so arranged that a portion of, or all the air may be diverted around the heater, and passed through a cold air duct, as shown in Fig. 232. Modifications are effected in details, a common one being that in which a re-heater is used in connection with an air-washer. In this, the air is drawn through tempering coils, which raise it to the minimum temperature required, and air that is wanted at a higher temperature is blown through a re-heater coil, as shown in Fig. 233, above.

The air washer is included, when, in crowded cities, the installation is used for heating and for cooling. It cleans the air from dust and impurities. It lowers the temperature of the air delivered to the pipes in hot weather, and regulates the moisture content, or humidity. In summer time, when it is desired to cool the air which enters at a high temperature from outside, and which has a high relative humidity, it is brought into contact with the air washer and chilled down to the dew point, or that of complete saturation. Beyond this, if the temperature of the water is low enough, further cooling will cause moisture to be condensed and the temperature of the air will be lowered until it becomes nearly as cold as the water. The air leaves the washer at a low temperature, but in a saturated condition, Being admitted in this state to the building, its temperature will rise in contact with the warmer

THE ARRANGEMENT OF MACHINE SHOPS; HEATING AND VENTILATING.

Fig. 237.

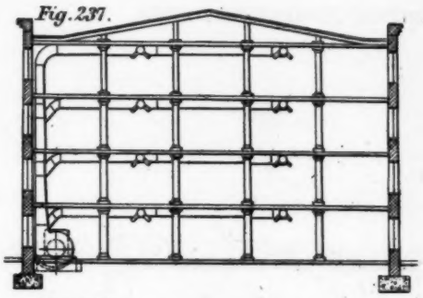


Fig. 238.

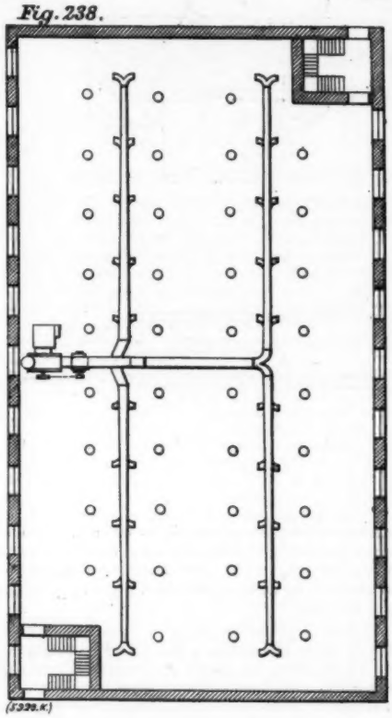
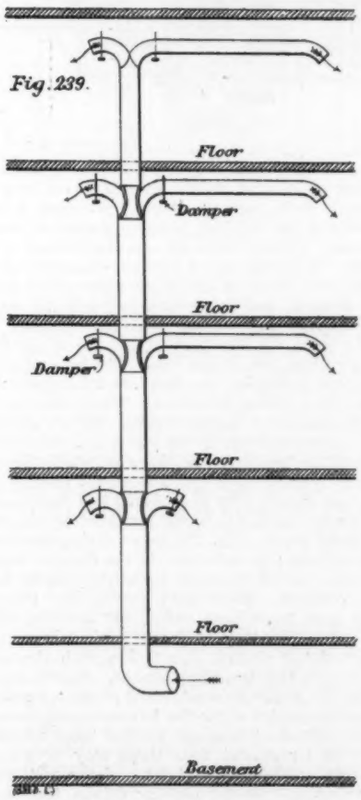


FIG. 240. ARRANGEMENT OF PIPES IN A GALLERIED SHOP; THE STURTEVANT CO.

Fig. 239.



FIGS. 237 TO 239 ARRANGEMENT OF PIPES IN STORIED SHOPS; THE BUFFALO FORGE CO.

air, and its relative humidity will fail as it displaces the latter. In the winter time, the air is heated before it enters the washer, with the result that its relative humidity is lowered. The absorption of moisture by the air from the water in the washer raises its humidity, and lowers its temperature. The air temperature is raised in the re-heater, and the relative humidity lowered, and the air, now suitably charged with moisture is fit to be discharged into the building. The water is supplied to the spray chamber, Fig. 233, in the form of a fine rain, at a pressure of from 5 lb. to 9 lb. per square inch. Eliminators are fitted, to effect the removal of moisture in suspension. These are metal sheets seen in Fig. 233, over the sharp edges of which the air is caused to change its direction several times.

In the case of large shops of the ground-floor design, heating as already stated takes precedence of ventilation, and is made the basis of calculation. The changes of warm air that supply heat losses provide ample ventilation.

The fall of temperature within buildings is due to the loss by conduction and radiation through walls, windows, doors, roofs &c; and to that caused by leakages. In the plenum system, the heat supply which makes good the loss from conduction and radiation is measured by the difference between the average temperature within the building, and that of the warmed air as it is discharged into the shop. The loss by leakage is measured directly by the difference between the indoor and outdoor temperatures. This represents dead loss, since it does not perform any share in heating.

The conductivity of surfaces is estimated by the number of heat units transmitted per hour by a square foot of surface for each degree of difference between the temperature within and without the building. As floors, walls, and roofs contain timber, stone, brick, glass, &c., the areas of each have to be regarded separately. Co-efficients have been worked out for these, and embodied in a table compiled by Alfred R. Wolff, which has been adopted in heating calculations.

Table of Values representing the Heat Transmission in Units per Hour, per Square Foot of Surface, per Degree difference in Temperature.

By Alfred R. Wolff.

	The coefficient for each square foot of brick wall.									
Thickness of brick wall in inches ..	4	8	12	16	20	24	28	32	36	40
Coefficient ..	.658	.458	.315	.258	.228	.194	.165	.143	.129	.114

1 square foot wooden beam contruction as planked over or ceiled	flooring	0.083
	ceiling ..	0.104
1 square foot fireproof construction, floored over	flooring	0.122
	ceiling ..	0.145
1 square foot single window		1.215
1 square foot single skylight		1.03
1 square foot double window		0.572
1 square foot double skylight		0.021
1 square foot vault light		1.48
1 square foot door (65 cent. per wood, 35 per cent. glass)		0.572
1 square foot door (plain)		0.414

These co-efficients are multiplied into the number of square feet of the different constructions. The result gives the heat loss for every degree of difference between the inside and outside temperatures, and the quotient being multiplied by the total difference in temperature gives the number of B.T.U. lost per hour. But here again, the need of expert advice arises, for the local conditions modify the co-efficients by from 10 per cent. to 50 per cent., depending on the exposure of the shop, and the intermittent or the continuous character of the heating. Any percentage amounts of this kind must be added to the number of heat units previously estimated to get the total loss from conduction and radiation, to which leakage loss is added. The sum total is the number of cubic feet of air which must be delivered at the temperature necessary to make good the heat losses.

The distribution of the air, after it leaves the fan and heater concerns the determination of the dimensions and arrangement of the pipes or ducts for its most efficient transmission.

Although velocities should as a general rule be kept low, yet there are limits to minimum rates if ventilation is to be efficient. The movements of air currents where they come in contact with the body is limited to a rate of about 3 ft., per second if a perceptible draught is to be avoided. A total change of the volume of air in a factory is made in from 20 minutes to 30 minutes. The heating engineers give tables from which pipe diameters

SCRAP METAL BALING PRESS.

CONSTRUCTED BY THE CANADIAN-AMERICAN MACHINERY COMPANY, LIMITED, ENGINEERS, LONDON.

Fig. 1.

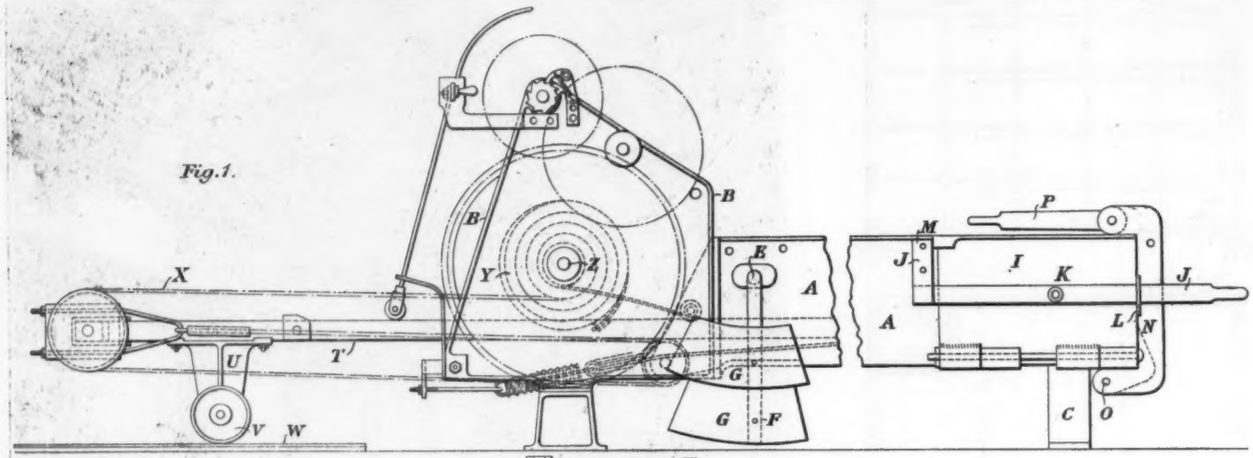
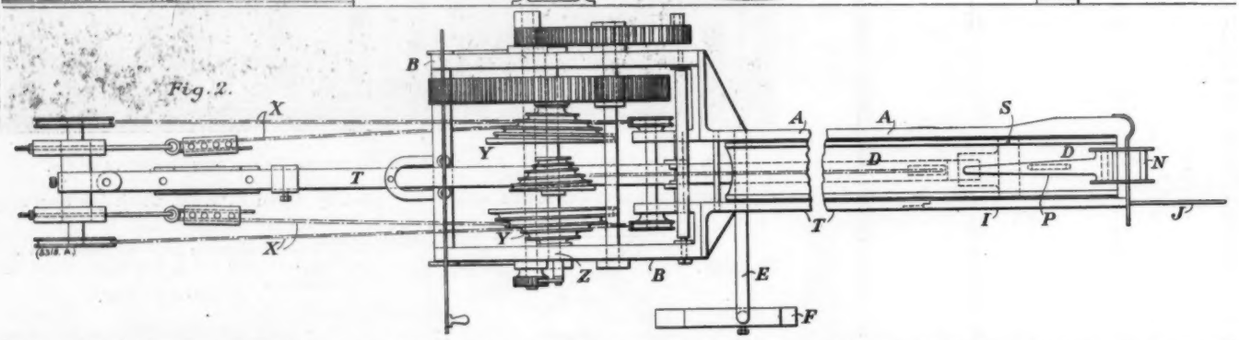


Fig. 2.



for all conditions are readily obtained. The loss of pressure due to friction increases directly as the length of a pipe, and as the square of the velocity of the moving air. Fifty diameters of smooth pipe produce a loss which corresponds with the velocity head. Round pipes are preferable to those of square section. Smooth steel pipes cause less friction than brick flues do. Sharp elbows must never be introduced. Bends of 90 deg. should be constructed with a radius of curvature on the inner side at least equal to the diameter of the pipe. Branch pipes ought never to be inserted at right angles, but should start with a curve, leaving the main at an angle of 45 deg. or less. Diameters of pipes, as diameters are reduced farther from the fan, must be changed with tapering connections. When they are divided to discharge in two directions, the branches must be tapered. When unequal resistances are encountered beyond the point of division, consequent on differences in areas, and lengths of the branches, dampers are fitted at the junction, as shown in Fig. 234; these dampers can be adjusted from the outside to suit the requirements, and then fixed permanently. Brick and concrete are often employed for flues and ducts built underground and into walls, and glazed tile piping, or hollow tile are suitable for passages of small dimensions. Galvanized steel is built into brick-flues in the walls of buildings. Brick-work flues are sometimes lined with terra cotta. Concrete ducts are constructed cheaply on forms. They are finished smoothly with a coating of cement, or a galvanized steel lining is inserted. Masonry work can only be employed when, in the case of new shops, the heating and ventilation installation is designed as a part of the buildings.

In the usual ground-floor shop the most suitable arrangement is to locate the fan and heater on a platform near the centre of the building, and then to discharge the air into horizontal pipes disposed round the sides of the shop, high up, clear of machines and to provide down-branches at intervals, which direct the air towards the walls not far from the floors. Thus the walls which are coldest are warmed and the air, returning along the floor, warms the lower areas, and thence ascends to the roof. In narrow shops, a range of pipes is carried down the centre of the building, being supported on the roof trusses, whence branches are distributed to each side. If a single row of piping is located at one side only, and the air is discharged right across, the hot air tends to rise to the roof before it has warmed the lower part of the building. Another way is to place the heater about mid-way of the length of the shop, but on one side. The fan outlet being directed upwards, branches into two pipes, which run in opposite directions. These are provided with outlets on opposite sides, one set delivering the air towards the walls, low down, the other set across the building. In shops in which the air is forced through very long distances, a small number of large outlets is to be preferred to a large number of smaller ones, due to the increased friction losses in small pipes. Fig. 235 shows a shop in which a single main pipe is located in the division between two spans, and the down-discharge pipes lie beside the columns. These have double-duct openings, The main pipes have rectangular sections, simply in order that they may not project beyond the sides of the girders, to interfere with the movements of the travelling cranes. Where the dimensions become reduced, round pipes are employed.

In the storied shops the fore-going arrangements are modified. Though in general those which are suitable for ground floor shops may be repeated concerning the pipe systems and the methods of distribution, yet in certain details the storied buildings require a separate treatment. The ground floor shops are lofty, the others are not. The presence of roof principals, of galleries, of moving pulleys and belts, of travelling cranes in the first, and their absence in the second, are taken into account. The floors may be served with a system of overhead pipes similar to those which are installed in the ground floor shops and with the same alternative variations. But more often, one main pipe is used, located either on the lower floor, or in a basement, where also the fan and heater will be established. Vertical ducts in connection with the main pipe, convey and discharge the air to each floor. These ducts are built in brick in new shops, as shown in Fig. 236, page 112. But if the system has to be installed in an existing building, pipes of galvanised steel are used.

Another method is to carry up a single vertical pipe of large size through the floors from the main flue or the fan, as shown in Figs. 237 and 238, page 113, and from this to distribute the air to systems of pipes on each floor, as in Fig. 239, this being known as "the stand-pipe" system. The vertical flues are located at distances apart that range from 30 ft. to 70 ft. They open directly on the areas, but each duct is provided with a damper which is controlled by a rod that comes down within reach from the floor.

The galleried shop, an old and favoured design, retains the large ground floor area, and the lofty roof. Here the apparatus may be located in a gallery. Part of the air is delivered from an overhead pipe along the gallery, and down-pipes from the main supply the lower floor. In Fig. 240, the main pipe, which is arched to clear the stairs to the gallery, runs along the main shop by the columns, whence pipes discharge to the ground floor, and others of smaller diameter to the gallery above. When a galleried shop is of great width this arrangement is duplicated, apparatus and piping being installed alike on each side of the building. An alternative system places the fan and heater outside the building, about midway of its length. The heated air is delivered into a pipe underneath the floor, which going right across the shop supplies both sides of the building. Branch pipes are connected with flues carried vertically, having openings about 9 ft. above the ground floor, and others above the gallery floor discharging towards the walls.

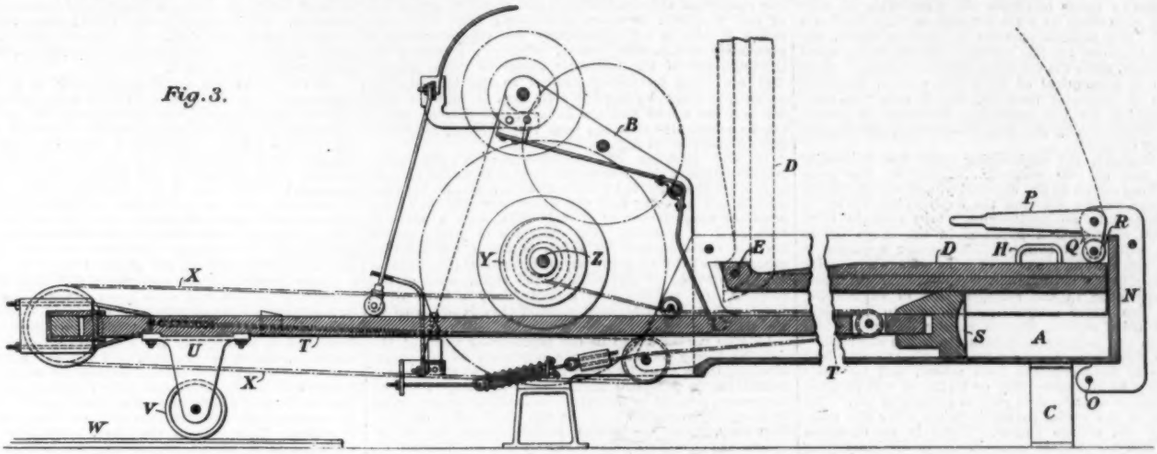
SCRAP METAL BALING PRESS.

We illustrate in Figs. 1 to 8 on the present page and on pages 115 and 122 a scrap metal baling press built by the Canadian-American Machinery Company, Limited, whose London offices are 8, Bouverie-street, E.C. 4. This firm has for many years made a specialty of baling presses. At the outbreak of the war they

SCRAP METAL BALING PRESS.

CONSTRUCTED BY THE CANADIAN-AMERICAN MACHINERY COMPANY, LIMITED, ENGINEERS, LONDON.

Fig. 3.

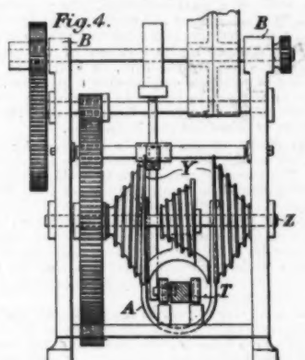


designed the machine which we now illustrate, and gave a cylindrical shape to the receiver, in which light brass and copper scrap and turnings can be compressed into self-binding cylindrical crucible charges of any given length. The pressure mechanism comprises a pair of scrolls of the fusee type, around which are wound suitable steel ropes connected with the ram. The adoption of the scrolls gives to the pressure ram a gradually decreasing speed and an increasing power as the charge in the receiver becomes more dense. The scrolls are carried on a shaft driven by gearing, and the latter, combined with the scrolls, will develop an effort in the ratio of 1 to 575. The total load varies with the tightness of the driving belt; with reasonable tightness, a driving power of 150 lb. is obtained, giving a total baling pressure on the material of 150 lb. by 575, or 86,000 lb., about 40 tons. This, as will readily be seen, provides a means by which the material to be dealt with can be greatly reduced in volume. Ample strength has been given to all parts to withstand the maximum loads, and due protection has been provided against possible overloads.

The machine is illustrated in the diagrams, Figs. 1 to 4, the references to which are the following: A is the box, or receiver, either cylindrical or square in shape, in which the material to be baled is placed; it is supported at its inner end by the main headstock framing B and at its outer end by the foot C. The receiver is closed by the cover D, which is pivoted on the shaft E located at the inner end of the box; the shaft E is cranked at the end F to carry the counterweights G which control the raising and lowering of the cover when it is acted upon the hand grip H. A hinge side door is provided at I; this is turned down for removing the scrap bale from the receiver. The side door is held in position when baling takes place by the catch lever J, which is pivoted at K, and engages the catches L and M. For holding down the cover, the bent lever N is provided, which is pivoted at O and ends in the hand lever P above the cover; the bent lever is fitted as shown in Fig. 3, with the small lever Q provided with the roller R which presses upon the cover when closed. The ram inside the box or receiver is marked S; it is secured at the end of the long plunger T, the other end being carried at the required height by the support U, on which are journalled the rollers V which travel on the rails W fitted on the floor-level. The longitudinal movement of the ram for compressing purposes is effected by means of steel cables X, one end of each of which is at the largest diameter of the fusee pulleys Y fixed upon the shaft Z journalled in the headstock framing B, the cables passing over guide pulleys, mounted upon studs, also carried by the headstock framing B. The cables thence pass rearwardly over pulleys mounted at the rear end of the plunger, eyebolts and screw adjustments being provided as shown in Figs. 1 to 3, to tighten the cables as required. The fusee shaft Z is driven by a set of gearing from the main operating shaft of the machine, at the top of the headstock framing, in which are fitted fast and loose pulleys, together with a spur pinion which forms the first member of the gearing.

The operation of the spur pinion, gearing, scrolls and cables forces the ram forward in the receiver and compresses the material contained in the latter. When the ram is drawn in close to the headstock framing, the material in the receiver is in a loose condition; when the machine is started working, the scrolls act upon the cables at their largest diameters;

Fig. 4.



as the ram advances the cables are acted upon by gradually increasing leverage of the scrolls, the greatest power being exerted upon the ram at the time when the compressed material reaches its maximum density. The machine is stopped automatically by the action of a small adjustable inclined plate on the plunger, shown in Figs. 1 to 3, close to the eyebolts and screw adjustments. When the plunger moves forward the inclined plate engages the roller of an inclined rod and fork, which shifts the driving belt from the fast to the loose pulley. The plunger is returned by hand to its original position by means of the central scroll shown in Figs. 2 and 4, and a third cable which passes round a small pulley in the rear of the ram (see Fig. 3), the end of the cable being taken rearwardly and secured to a clamp and spring device. By rotating the shaft in the opposite direction, the third cable draws the plunger back as it coils upon its scroll, the compressing cables being at the same time unwound from their scrolls, when the machine is ready for the next operation.

The receiver varies in shape and dimensions to suit the varied requirements; thus for preparing material for charging into crucibles, a bale about 6 in. in diameter and 8 in. long is most suitable. If the material is very springy, it is sometimes advisable to wire the bale under pressure to prevent it opening too far when released. Provision for wiring is made. The machine is illustrated in Figs. 5 to 8, on page 122, the view, Fig. 7, showing the compressing and return gear.

LOCOMOTIVE AND WAGON CONSTRUCTION IN GERMANY.—The Prussian railway department has given some information about the large number of engines and wagons built during the war. Of locomotives 4,900 had been built, an increase of 30 per cent. compared with peace times, and of wagons 120,000, also a great increase in the figures of the past. Before the end of the current financial year a further 1,700 locomotives, and 29,000 goods wagons were to be delivered. The construction of a fourth track on several lines was under contemplation, and during the whole of the war the capacity of the lines had been increased, especially in the western part of the country. It had been found necessary to reduce the passenger traffic to 55 per cent. of the peace service.

THE ENGINEERING PUPILAGE AND THE ENGINEERING TRADE APPRENTICESHIP.

By ALGERNON E. BERRIMAN, O.B.E., Chief Engineer, Daimler Company.

1. THERE is a preliminary issue that every parent must decide when supporting his son's desire to become an engineer. He must settle whether the training is to be that of an engineering pupil or that of an engineering trade apprentice. The terms pupil and apprentice in relation to engineering are often loosely applied, but in this memorandum they have been given a definite significance for the sake of precision and without any desire to imply permanent distinction of class. On the contrary, it is most important to bear in mind that the very broad outlook associated with the educational career of the engineering pupil can no more camouflage a narrow intellect than the modest beginnings of an engineering trade apprenticeship can prevent real ability from expanding to a great career. Some of our most eminent engineers commenced as apprentices, but it is worthy of note that the Admiralty Dockyard system of apprenticeship, which has been responsible for providing some of the most notable successes,* incorporates the features of a pupilage in the higher education of the selected boys. For this reason, if for no other, therefore, the engineering pupilage may reasonably be regarded as a legitimate and proper course from the commencement for those who possess the necessary means and ability to take thorough advantage of the educational facilities thus brought within reach.

2. In both systems of education there is a common convergence of aim; the apprentice seeks to acquire expert skill in the use of his hands in order that he may possess once and for all the means of earning his living at a trade, while the pupil sets out to develop proficiency of intellect in order that he may be qualified to make discovery by research, to invent useful designs, to manage their economic production, or to promote their distribution through the channels of engineering commerce. The pupil's initial outlook is obviously more ambitious than that of the apprentice, but its successful achievement ultimately depends on the acquisition of a degree of wisdom that is not the exclusive gift of any one particular course of training. Life itself is the greatest educator, and it may happen that the daily experiences of the apprentice among his fellow men will lead him to get there first.

3. The engineering pupilage is necessarily based, in the absence of a scholarship, on the ability of the parents to provide a thoroughly broad educational foundation in this branch of technology and should also be founded, for the reasons above stated, on evidence that the boy warrants the expense. The actual cost depends on circumstances that vary with the standard of living and

* The following is a list of some distinguished dockyard apprentices:—Sir Nathaniel Barnaby, K.C.B., Director of Naval Construction; Sir F. H. Biles, LL.D., D.Sc., Professor of Naval Architecture, Glasgow University; Sir A. J. Durston, K.C.B., engineer-in-chief; Mr. Frank Elgar, LL.D., F.R.S., Director of Dockyards, Admiralty; Vice-Admiral Sir George Goodwin, Engineer-in-Chief of the Fleet; Mr. P. Jenkins, Professor of Naval Architecture, Glasgow University; Sir J. B. Marshall, K.C.B., Director of Dockyards; Sir Thomas Mitchell, M.V.O., Manager, Constructive Department, Portsmouth; Vice-Admiral Sir H. J. Oram, K.C.B., F.R.S., Engineer-in-Chief of the Fleet; Sir William Pearce, Bart., managing director, Fairfield Works; Sir Edward Reed, Director of Naval Construction; Sir William Smith, C.B., Superintendent of Contract Work, Admiralty; Sir J. P. Thearle, D.Sc., Chief Ship Surveyor, Lloyd's; Sir S. Philip Watts, K.C.B., F.R.S., Director of Naval Construction; Mr. J. J Welch, M.Sc., Professor of Naval Architecture, Durham University; Sir W. H. White, K.C.B., F.R.S., Director of Naval Construction.

education to which the prospective pupil has been accustomed.

4. Fundamentally, an engineering pupilage comprises two parts, the works period and the college course. Each lasts about three years, and opinions differ as to the sequence in which they should be taken. In Scotland, the university terms facilitate the alternation of class work and shop work on what is known as "the Sandwich system." This scheme appears in various forms, one of which provides for the summer months being spent in the factory, while the winter is passed at college. Such a system is economical of time and money, but it is decidedly an intensive training, and it does not leave much opening for the educative influence of travel, which is facilitated by the long vacations of the English University Calendar.

5. In England, the engineering pupil has ordinarily followed one of two methods. Either he has gone straight from school to the university, and completed his course there before entering the engineering world, or he has gone into an engineering works straight from school and completed a pupilage in the shops before going to a technical college. The former sequence is probably best suited to the boy of great academic capacity who is likely to attain high honours in university subjects and to specialise in the research side of engineering science. The latter alternative has less to commend it than a third scheme that is worthy of much wider recognition and support than hitherto it has received.

6. This third plan provides for the direct entry into the works of boys straight from school, and for their transference to the university or technical college after the completion of their first year of industrial life. The remainder of the works period is taken after the completion of the college course. There is an immense practical and humanistic value in the preliminary year in the shops. It tends to focus more clearly in the boy's mind a conception of the true relation of education to life, and it helps him to establish, while he is still young, human relations with his fellow men of lesser opportunity, which will be invaluable to him later on when he becomes a master. Moreover, it is possible by allowing time off for attendance at school to maintain the continuity of systematic mental instruction that is essential to the carrying out of the higher educational plan.

7. In order to carry through this scheme satisfactorily, it is evident that the engineering pupil must be able to gain admission to the university or technical college in due course, without the trouble, and to some extent danger of having to prepare for an entrance examination in the limited spare time of his works period. In short, the prospective engineering pupil should make a point of satisfactorily passing one of the examinations that are of matriculation standard.* It may be said without any hesitation whatever, that the long hours and hard work of an engineering factory constitute too much of a physical strain to permit of an examination of this standard being worked for with any chance of success in spare time only.

8. Boys who have the advantage of being at a public school are well advised not only to matriculate before leaving, but to stay on at school for a further year, if by so doing they become prefects. For those who in later life are to have the management of men, practical experience of the traditions of public school control possesses a very real value.

9. Probably that which causes parents and boys to deviate too much and too soon from the broad educational highway, is a mistaken belief in the importance of early specialisation in certain subjects that they are seldom able precisely to define. Engineering, to say nothing of life itself, is established on too broad a foundation to justify this view, and nothing helps more readily to an appreciation of this fact than to bear in mind that there are three great departments of engineering, which may be defined as :—

Engineering science.
Engineering production.
Engineering commerce.

10. In any one of these departments, a broad educational foundation is an essential requisite to the support of high attainments, but an engineer who commences life in one department may, by force of circumstances or inclination, come to undertake a post of responsibility in an allied field of work, and it is particularly when such changes as these take place that the practical value of a liberal education is realised at its full worth.

11. In brief, therefore, it is convenient to consider that, for the purposes of making a start as an engineering pupil, the first accomplishment and evidence of ability should be the passing of the matriculation examination, coupled with the willingness of the parent to provide facilities for a university career or equivalent college course, as an integral part of the engineering pupilage, which will also comprise at least three years as a period to be spent in the works.

12. Those who stay at school after they have matriculated may conveniently modify their curricula under the advice of their masters, but there is no fixed plan on which the subjects can be selected, because such choice must be determined largely by what has gone before, and by the educative ability of the individual, as well as by his preconceived ideas of a career. Also, it must be borne in mind that while some knowledge of science is becoming more and more essential to the man of affairs, a knowledge of affairs may be equally important to the man of science. Specialisation at this period is less vocational than educational and it chiefly serves one of two purposes, as above described; that is to say, either it affords an opportunity for supplementing a previously too narrow course, or else it increases the thoroughness of the student's grasp of those studies that are more intimately related to the immediately succeeding phase of his life. In fine, it forges a link between the school and the factory, and thereby facilitates a continuity that has been very difficult of attainment under the old regime.

13. The problem of specialisation in the post-matriculation period stands quite apart from the general advantage to be derived from a closer association between schools and industry and the wider appreciation of the practical applications of science that such a state is calculated to promote. The majority of young minds are not characterised by much capacity for abstract thought, and the frequent use of industrial illustrations for the purpose of crystallising the significance of the subjects and problems of school study relates to a development of educational method that is much to be desired.

14. The period ahead of the engineering pupil at the time he leaves school covers a minimum of six years, of which three must be spent at college and three under instruction in practical work. It is in many ways an advantage, notably in the matter of facilitating admission to scientific societies, such as the Institution of Civil Engineers, that the works period should be under agreement, which may conveniently but not necessarily take the form of a legal indenture. In any case, it is advisable that the aim of the works period should be to acquire a comprehensive and reasonably thorough understanding of the nature and detail of the particular business carried on by the firm, as well as to lay the foundations of practical engineering experience. Thus, the pupil is advised to complete his three years under one master rather than to go from one firm to another for the sake of miscellaneous knowledge.

15. The choice of the firm is governed by circumstances, not unlike those that determine the choice of a school. The essential points are that the opportunities for learning should be comprehensive of their kind and supplemented by instruction. Mechanical engineering is commonly regarded as a good foundation for the practical side of an engineering career, but the particular branch may be a matter of choice. Admission to the studentship grade of some Institutions, *e.g.*, the Institution of Civil Engineers, can only be obtained by pupils of corporate members.

16. The preliminary year in the works, as has already been explained, has for its principal object to establish human relations between the pupil and the men. It also gives point and added interest to his later university work. At college he will begin to find his true intellectual level, and may deviate considerably from the particular fields of interest that previously attracted him most. In some cases, a special ability and liking for research may be developed, in which case a fourth year devoted to laboratory work is all to the good.

17. The second period in the works, which is of two years' duration and completes the pupilage, is devoted to obtaining a systematic course of experience in successive departments, the choice of which will be governed to some extent by the pupil's inclinations and should be co-ordinated in such a way as to tend towards a natural convergence of work. Thus from the completion of the pupilage onwards, the young engineer must hold a salaried position by merit, and thoroughness in a particular branch of work will be his chief claim to consideration during the immediately ensuing years.

18. The tendency in engineering works is more and more to create a staff of specialists under the co-ordinating direction of a chief, but there is one thing that the prospective engineering pupil should recognise very clearly from the first, namely, that none but those in the very first rank can hope to hold their place in such a capacity. Success as a specialist, however, is very closely related to the keenness of intellect developed by the breadth of the early training, which is why it is a false policy to seek a short cut by specialising too soon. The truth of this assertion is perhaps more readily realised in reference to the departments of engineering production and engineering commerce than in what has here been described as engineering science. The successful engineer-manager is not less a specialist as to vocation than the engineering chemist, but it is perhaps easier in his case to appreciate the importance of a liberally educated mind.

19. The career of the apprentice differs fundamentally from that of the pupil in that skilled handicraft, rather than proficiency in brain power, forms its basis. The apprentice enters the works to acquire skill at a man's trade in order that he may be able to demand a skilled man's wages when he becomes of age. The engineering pupil does not ordinarily spend sufficient time in any one department of the works to acquire expert personal skill at the operations of any particular trade. He learns how a thing should be done rather than how to do it himself, and in this very deficiency of personal skill is to be found one of the significant reasons why the pupil must make good in a very wide field of technology if he is to retain the confidence of the workman over whom he comes to be set in management. The workmen of an engineering factory are not inclined to be lenient with ignorance in those who direct them, nor are they always willing to be led by one who is right unless they also respect him as a man of character.

20. An apprenticeship is not merely a matter of indentures. It may be just as thorough without document, provided that it is based on a moral understanding, but it is shortsighted of the parents of a boy not to provide him with permanent evidence of the thoroughness of his training, and the indenture is the particular form of certificate that has always been accepted without question. For some purposes, as, for instance, admission to the Freedom of Cities, and to membership of certain Institutions, the indenture is the only kind of document that is readily recognised.

21. In its essence, an apprenticeship is a tri-party agreement: by the master to give instruction, by the boy to stay the course, and by the parent to give his son maintenance and encouragement. The fact that so many boys are not apprentices is due in part to the financial need that forces some boys to make the greatest possible contribution to the family income from the moment they are free to leave school at the age of 14. In other cases, it is due to lack of appreciation of the importance of apprenticeship on the part of the parents, who could quite well afford to give their sons the benefits of this superior training. In the interests of the nation and of society there is the greatest need for fostering a proper regard for the real value and dignity of this essentially British and once great national institution. It was largely in consequence of the Civil War of 1649–1660 that the Elizabethan apprenticeship system, which flourished so strongly in the sixteenth and seventeenth centuries, waned in England, and not the least of the attendant evils of the present war is the great increase it has made in the industrial army of casual boy labour, the members of which, instead of learning skilled trades, are drifting from one situation to another where the pay is higher. This reason, therefore, adds force to the fundamental argument, provided by the intrinsic merits of the case, for doing everything possible to reinstate apprenticeship in the esteem of the people.

22. Of the many apprenticeship schemes that are and have been in vogue, none possesses a longer or more successful record than the Admiralty Dockyard system, first introduced in 1843. The names of the many great engineers who were trained under it should form a lasting encouragement to apprentices in every era. It is essentially founded on the principle that the boy apprentices himself to learn one of the engineering trades, and is not only instructed therein by the master, but is also afforded facilities for continuing his school studies in the day-time. It is this latter opportunity that has been the first key to the success of the scheme, for it has enabled the management to select boys of special mental ability (who have also acquired early skill at their trades) for transference to a wider sphere of training, and ultimately to the higher and broader education that characterises the engineering pupil's career. The result has more than justified the expenditure of the public money involved, but it would not have been possible even to attempt such a scheme except on the basis of the reciprocal trust and interest engendered by an apprenticeship agreement. Experience shows that while it is only fair to give all boys an opportunity of obtaining further day-time schooling, its continuance is only justified (under existing restricted national facilities) in the case of those who show that the stimulus of personal experience has awakened latent intellect; and even for these selected boys, such further school education can only achieve its true purpose if taken in conjunction with a proper vocational training such as is provided by an engineering trade apprenticeship. It is the clear duty of every man to contribute his share of service to the community of which he is an individual member, and the most fundamental form of such service is to earn one's own living in the highest kind of work of which one is capable and at which one is efficient. A liberal education tends to increase the mental capacity, but it would be illogical to provide it at the State expense and in works hours for boys already in industry who fail to give evidence of a desire to train themselves thoroughly in their shop work.

23. Given this desire as expressed by an agreed apprenticeship, then the employer knows that the boy of educative ability is worth teaching, not only in the works, but also at school, because he has promised to stay the course. The school studies in such a curriculum should relate primarily to the boy's life, in order to secure the mental focus provided by daily contact with material expressions of the world of thought, but the teaching of technology, nevertheless, may be liberalised not only by reference to its biographical romance, but by expansion into its environment of history and by constant regard to the incidental, if not to the specific teaching of the English language. In the Admiralty Dockyard school courses, great insistence has always been laid on the fundamental importance of mathematics to proficiency in the study of engineering science, and the remarkable series of successes achieved in open competition by Admiralty Dockyard apprentices justifies the high regard paid to what is, after all, no less than the key to the whole realm of quantitative thought.

24. Character training and physical development, preferably through organised recreation, are not less important to human evolution than is the expansion of mental capacity. On the contrary, good health and right morals are of the very first consequence to the nation, and as ideals they are more nearly within universal reach than cleverness of mind. School buildings are not necessary to the fulfilment of this aspect of education's aim, but the voluntary worker is essential, for it is on his efforts that such admirable schemes as the Boy Scouts' Association depend for their success. Here is a place in the social life of the community where the pupil and the apprentice can meet on common ground outside the shop and establish a personal regard for each other that may very well last through life.

* The following examinations qualify for admission to all universities:—Oxford and Cambridge Schools Examination Board Higher Certificate; Oxford and Cambridge Schools Examination Board School Certificate; Oxford University Responsions (except London); Oxford University Senior Local Certificate; Cambridge University Previous Examination; Cambridge University Senior Local Certificate; London University Matriculation Certificate; Joint Matriculation Board Matriculation Certificate; Scotch Education Department Leaving Certificate, Higher Grade (except Oxford)

25. As our national scheme of education exists at present, the boy who is clever at school is reasonably well provided for by scholarships and the like, so long as he continues to climb the approved educational ladder leading to the orthodox academic career. But if at some point in his ascent his accomplishments fall short of the highest plane, he is apt to drift into positions of insignificant utility through lack of suitable guidance at the critical time. Many of the boys who climb thus far and no further would probably do exceedingly well in industry if it were made possible for them to take an apprenticeship or pupilage at a suitable point in their career. To this end, the employer can at least assist by starting such boys at the apprentice rates of pay corresponding to their age, and in all matters of privilege based on time it ought to be the common custom to allow the years spent at school to count equally with those spent at the factory. Broadly speaking, the boys fitted for apprenticeship may be grouped as follows :—

(*a*) Those who leave the elementary school at 14 and who spend seven years learning their trade.

(*b*) Those who, having been transferred to a Junior Day Technical School at the age of 12, enter industry at 15 and complete their vocational training in six years.

(*c*) Those who, having been transferred to a secondary school at 12, enter industry at 16 and complete their apprenticeship in five years.

26. There remain those boys whose educational ability in school subject warrants a continuance of academic study at the nation's expense beyond the matriculation standard, with a view to the subsequent completion of a University career. This matriculated class may be divided as follows :—

(*d*) Those who display good all-round ability but no special brilliance, and who would be well advised to enter industry for a year before taking the university course.

(*e*) Those who appear to be scholars in embryo of the first rank, and therefore fitted to pursue forthwith their higher academic education, with a view to engaging ultimately in some specialised branch of research at the university itself or in some equivalent field of service in association with private enterprise of industry.

27. In the case of classes (*d*) and (*e*), it is an engineering pupilage, rather than a trade apprenticeship that is indicated as the proper kind of works instruction, and in both groups the post-graduate period of the pupilage ought to comprise two years in the works, for the object in both cases is to give the engineer in embryo a thorough introduction to the field that he is about to serve. It is the breadth of view afforded by this sort of pupilage that enables the practical side of the vocational training of the engineer to contribute so much towards the foundations of a liberal education.

28. While under the existing scheme of things it is possible for the clever boy to pursue the last-mentioned course (*e*), it is a fact that relatively few of those who reach the university as scholars become engineering pupils afterwards. To that extent, therefore, the engineering industry does not at present benefit greatly from State expenditure on higher education. At present, the career indicated by clause (*d*) does not exist as a State-aided scheme, but it would probably thrive if money were provided for industrial scholarships.

29. By an industrial scholarship is meant a scholarship that benefits the boy who is already in industry, and inasmuch as the initial award under scheme (*d*) is necessarily made by the schoolmaster, it follows that the confirmation of the candidate's nomination ought to be made subject to his satisfactory industrial progress, and therefore to his employer's approval. Under this form of the scheme, the preliminary year of the works period of the pupilage would become an integral part of the period covered by the scholarship, which would then be applied towards maintenance, on the assumption that the pupil receives apprentice wages corresponding to his age at least.

30. Industrial scholarships are also needed to provide for the higher education (on the Admiralty Dockyard method) of those boys of classes (*a*), (*b*) and (*c*) who develop greater educational ability under the stimulus of a properly instructed apprenticeship that embodies efficient part-time school work. It is not in the nature of things, nor is it necessary, that the products of this kind of education should in all cases pursue a course analagous to those of either clauses (*d*) or (*e*), but there is undoubtedly an intermediate form of higher education that might be brought within reach of many boys from classes (*a*), (*b*) and (*c*) that would do much to complete and thereby render more fully valuable to the community the education thus commenced at the nation's expense.

31. Of the boys in these classes who quickly become skilled at the handcraft of their trade, some of the most fit might be selected for a limited engineering pupilage or wider apprenticeship. Some such scheme seems desirable as a means of throwing open the door through which boys from these classes might enter the drawing office, the estimating office, test rooms, experimental shops, and other branches of engineering work that would probably afford a more attractive field of interest to a considerable number of young mechanics than the routine operations of their trades. Moreover, the work done in such places would be all the better for the presence of men thus thoroughly trained in workshop practice. Apart from these alternative vocations, however, there is the important field of executive work in such positions as those occupied by charge hands, foremen, and superintendents, where the benefits of a broader education are of incalculable value in contributing to the much desired evenness of temperament and balance of mind, to say nothing of the wider and more accurate knowledge of technical facts that men in dual positions should possess. Such a pupilage, superimposed upon an apprenticeship at about the age of 19, might very conveniently operate on the Scotch "Sandwich" system, if facilities for this class of combined practical and theoretical work were developed as they might be in all industrial towns. With such educational facilities on the spot, it would be by no means impractical to provide a thoroughly effective three years' course, taking the winter months at college and the summer months in the works. Such a plan as this would undoubtedly meet a very real need for higher education of a kind that, while not aiming at the highest university standard, would suffice, nevertheless, to round off the preliminary training afforded by part-time voluntary school study.

32. In addition to this, it would go a long way towards meeting the case of the boy whose parents have been able to afford him a good secondary education, possibly at one of the best public schools, but who are unable to meet the additional cost of a university career. Many boys in this position desire to become engineering pupils, but it is difficult to advise them how best to do so as things are at present situated, because they undoubtedly carry on with a serious handicap in competition with those able to take a systematic college education, and their position becomes more difficult as time goes on. With improved facilities for local education, however, the requisite standard would probably be brought within reach of many such boys, and the field from which engineering would thus be able to recruit would be correspondingly enlarged to its advantage, without any direct call upon scholarhsip funds.

33. On the other hand, the financial side of the position is one in respect to which the engineering industry ought certainly to make a point of being as generous as possible, because it must be remembered that the nation's wealth is created, as Mr. Lanchester has emphasised in his second presidential address to the Junior Institution of Engineers, as the work leaves the tool, and the fewer the subsequent financial transactions, the less is the degree to which the net value of labour is discounted by unproductive services. In fine, it is sound economics for industry to pay the cost of the training of its own boys, because by doing so the cost to the State is less than when the Government collects and redistributes the funds. Notwithstanding this fact, however, it is apparent that State-aided, if not State-provided, industrial scholarships would do much to foster the best educational interests of the country.

34. It will have been apparent from the preceding remarks that there is a very great deal about the apprenticeship situation in England that is as yet uncrystallised, and the difficulty of crystallising it is considerably increased by the fact that conditions vary with the locality and differ in different shops of the district. It is, partly, to meet this variation that the Engineering Training Organisation has been formed, and it is hoped that a study of this relatively unexplored phase of technical education may do much to assist towards an improvement in the general position throughout the country. There is, however, no doubt that the root evil, and it is no less, of the present position lies in the almost unrelieved shortsightedness of the parent who sees no possible reason for choosing an apprentice's career for his son in favour of relatively highly paid boy labour. The question of the boy's future as a man seems to concern some parents not at all. Every employer is naturally willing to make use of the cheapest service that is available on the market, and there is no doubt that industry—and, therefore, the country generally—would be very adversely affected by any arbitrary and extensive curtailment of these existing economic facilities. Advocacy of apprenticeship for some does not involve the imposition of apprenticeship on all, and what has here been written has had for its object to throw into prominence the importance of recognising apprenticeship as the proper career for the most fit among the elementary school and non-matriculated secondary school boys of each generation. It is not to be supposed that every boy was apprenticed under the Statute of Artificers; indeed, the social history of these times relates that the child labour problem was as great then as it is to-day; none the less did it recognise that in apprenticeship lay the first key to its solution, because through apprenticeship a large percentage of the growing population learned how to conduct themselves as men in the best interests of the State.

35. Emphasis has been laid on the necessity for advancing the education of apprentices on the selective principle. It is only fair to give all boys the opportunity of having voluntary part-time schooling, but the continuance of the privilege should essentially depend on adequate progress. To force the brain against obvious educational disability is a waste of time and money. On the other hand, there is considerable evidence that the latent brain power may develop long after the normal school period, and no general scheme of education can be regarded as comprehensive unless it provides for this possible mental awakening. Capacity for education may be a physiological matter of heredity, but even when it is present, little is accomplished without genuine interest on the part of the student, and it is towards the engendering of this germ of individual concern that the educational ancillaries should be directed.

36. To this phase of the national educational programme the welfare movement might usefully link up the intellectual aspect of its organised recreation by taking charge of the evening entertainment. Between the regular evening classes of the technical institute and the "movies" or the street corner, there is room for a vastly useful field of educational endeavour having for its object to inspire interest by providing intellectual entertainment rather than to fatigue the brain by subjecting it to instruction. It is to this field that the meetings of engineering societies really belong; but they are necessarily restricted to a narrow and selective field. The boys' club, run in imitation of the men's club, is recorded by those who have most closely studied this social question, a failure of the first order. On the other hand, the organising of voluntary circles of common interest in subjects that can be carried on, preferably at home, in such a way as to encourage each boy systematically to develop his own individually on his own lines, is much to be encouraged. Music, singing, science, biography, geography, poetry and history all lend themselves to recreation if some voluntary worker with a sincere love for his subject presides over the periodic meetings of each circle and guides its members in the reading of a particular book or the study of a country in which he has travelled. It requires no great personal attainments to hold the interest of young boys in real experiences, nor to encourage the asking of questions in such a way as to foster some power of self-expression. One of the most important things to avoid is the stereotyping of communal interests in a rigid mould. There are always sufficient individuals to form a really enthusiastic group with a common interest, and it is such a pity to damp their ardour by forcing apathetic attendants upon their company. Welfare administered in gross tends to defeat its own object by infringing that liberty of the subject which is the dearest possession of the English mind. The essential point is to make the boys interested in something that they know they like doing, by being interested in them. Once established on these broad principles, the regenerative quality of such interest may be relied upon to make the movement live. Moreover, this tilling of the local intellectual soil is needed as a preliminary to the fruitful planting of such national interests as the Workers' Educational Association, the National Home Reading Union, and the University Extension Movement.

37. The evening classes of the district, too, could usefully be remodelled so as to form a part of this phase of education, because their present position in relation to the growth of part day-time schools is somewhat of an anomaly. They will soon cease to fulfil the purpose for which they were founded, and yet there is no doubt that the class-rooms and apparatus of these institutions should no more be closed in the evening than are the public libraries. Merely as accommodation, they might contribute much to the success of any intellectual welfare movement such as has been outlined above. In this connection, too, there is a considerable field for useful work in the organisation of special study classes for senior men who have laid the foundations of a fairly broad education and desire to advance their particular knowledge of mathematics, physics, chemistry, or the like. Here is the field for the voluntary worker in education that is pregnant with immense possibilities. It is commonly admitted that the crux of our educational difficulty lies in the impossibility of attracting the best teachers by the salaries available, but there are few men of high attainments in the leading positions of industry who would not be willing to guide the evening studies of a small volunteer class of enthusiasts for their own special subjects by devoting an hour or two a week to them during a reasonably short season. In any considerable centre of scientifically-conducted industry, it should be possible to engender a great spirit of interest in such matters if it were fostered in the right way and under suitable auspices. If, too, in the course of time, the greater firms established halls of residence for their pupils there would gradually grow up in the world industrial universities wherein the traditions of the old world of letters and the outlook of the new world of science might give birth to an era of greater enlightenment towards the true economics of life. It is the wider acceptance of the spirit of mutual interest in a common aim that is needed to accomplish this change of heart towards the world's affairs, and the thought naturally arises what great part might not the noble edifices of a united national Church play in the furtherance of man's progress towards such a universal scheme.

WATER POWER OF CANADA.—We read in *Canadian Machinery* that the water power available in Canada, so far as figures can be arrived at, amounts to a possible total of 18,803,000 h.p., of which less than one-tenth has been utilised up to the present.

CALENDARS.—Messrs. Richard Garrett and Sons, Limited, of Leiston, have sent us renewable date slips for their permanent aluminium almanac, and Messrs. E. T. White and Co., engineers' merchants, of Windsor House, Kingsway, W.C. 2, a very convenient diary and calendar combined with a writing pad.

THE LATE MR. THOMAS ANDERSON.—We regret to have to record the death, which occurred on January 15, at his residence, 1, Belmont-street, Hillhead, Glasgow, of Mr. Thomas Anderson, A.M.Inst.C.E. Mr. Anderson was a well-known engineer, especially in India, where he spent upwards of thirty-three years, thirty of which were in the service of the Royal Indian Marine. He was born in Greenock on April 29, 1842, and served his apprenticeship with the Caledonian Railway Company. He went to India in 1864, and joined the Royal Indian Marine three years later. Mr. Anderson became Chief Inspector of Machinery for H.M. Dockyards at Bombay and Calcutta in 1880. The following year he was appointed Engineer Surveyor to the Port of Bombay and a member of the Local Marine Board for the examination of engineers. In 1885, he became chief engineer. Mr. Anderson retired from the service in 1897, when he was highly commended for his work by the director of the Royal Indian Marine.

TRACTION ON BAD ROADS OR LAND.*

By L. A. LEGROS, of Acton, Member.

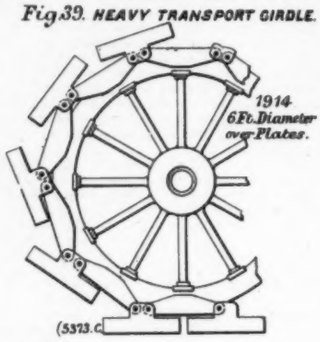
(*Continued from page* 88.)

Four-wheel Drive, Four-wheel Steering.—The Supertquad of the Walter Motor Truck Company, of New York, Figs. 23 and 24, Plate IX, is an example of four-wheel drive and four-wheel steering, and is shown in plan and elevation in Fig. 19; a semi-tractor is shown in plan and elevation in Fig. 20, Plate X. The transmission gear is shown in elevation and plan in Fig. 21, the front-wheel differential shafts with the cardan joints for the short driving shafts to the front wheels being shown in section and outside views. The method of driving the wheels by short articulated shafts is shown in Fig. 22.

Each axle is fitted with an automatic locking differential of the Walter type, which remains automatically locked for normal running, but becomes unlocked when necessary for example, in turning the car. The two Walter automatic-locking differential gears, Fig. 25, Plate IX, are, moreover, sufficient; the third differential gear on the main shaft, necessary in the case of ordinary differentials, is not required with this device, as either or both wheels on the axle which tends to overrun the other will become unlocked automatically, and will lock again as soon as the distribution of velocity becomes normal.

The vehicle is fitted with a pedal-operated transmission brake and a hand-lever operated back-wheel brake, both of which, owing to the fact that the main differential is either in gear or is locked, also act on all four wheels.

Fig. 39. HEAVY TRANSPORT GIRDLE.



The Jeffery quad shown in Figs. 26 and 27, Plate XI, is a four-wheel driving and four-wheel steering vehicle, better known in this country than the Walter. This vehicle is fitted with the M. and S. locking differential on each axle, Fig. 5, page 87 *ante*.

Some of the forms of body adapted to this chassis are shown in Fig. 28, Plate XI, and comprise two forms of hoist or tip bodies and two forms of special bodies for the transport of liquids, &c.

Four-wheel Independent Drive with Four-wheel Steering.—The Couple-gear electric truck, Fig. 29, Plate X, and also the petrol-electric truck, Fig. 30, on the same Plate, of the Couple-gear Freight Wheel Company, of Grand Rapids, Mich., afford examples of four-wheel independent drive with four-wheel steering.

The battery-driven car is shown in elevation, front elevation and plan in Fig. 29. The wheel is of peculiar construction, having two large-diameter bevel wheels enclosing the motor, which is placed out of square with the axle to a sufficient extent to allow both ends of the motor shaft to carry a driving bevel pinion. One of these pinions gears with the outer half of the wheel and the other with the inner half, so that the load on the motor shaft is balanced, a result further ensured by the introduction of an "evener" or compensating gear; the arrangement of the wheel parts is shown in Figs. 31 and 32, Plate XII. A channel frame carrying twin solid rubber tyres is secured over the two bevel-carrying discs forming the wheel. The gear reduction from motor to wheel is 25 to 1; the relation between tractive effort and speed is given in Fig. 33. The motor is carried on a short hollow stub-axle keyed to a taper seat in the steering knuckle and secured by a nut; the wires are led to the motor through the stub-axle pin. The wheels run on roller bearings and are fitted with hand holes with removable doors to give access to the

Fig. 37. WHEEL AND CHAIN-TRACK COMPARED.

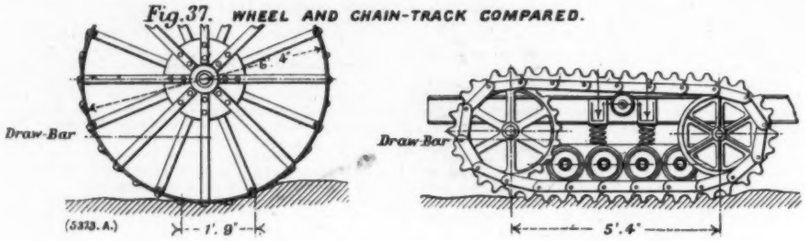


Fig. 38. BOYDELL GIRDLE.*

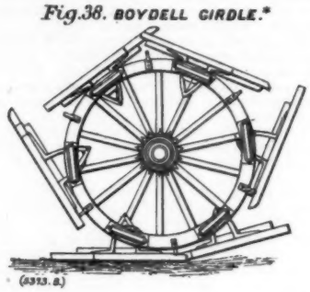


Fig. 40. PEDRAIL: EARLY FORM (DIPLOCK)

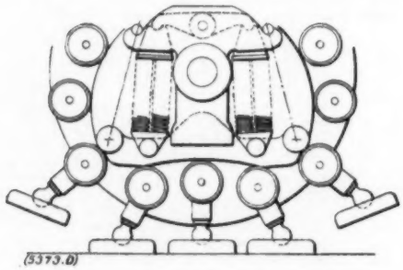


Fig. 41. SUPPORTING ROLLERS WITH AXES FIXED RELATIVELY TO TRUCK-FRAMES (CREEPING-GRIP).

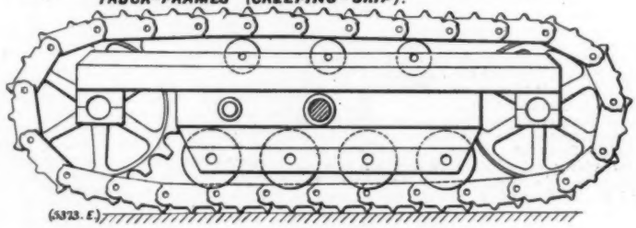


TABLE I.

—	Make and Description.	Normal Load.	Weight of Truck.	Total Weight.	Front and Back Wheels. diam.	Front and Back Wheels. width.	Track.	Wheel Base.	Turning Radius.	Width Overall.	Length Overall.	Platform Length.	Chassis Width Outside.	Clutch.
	Four-wheel Driven Vehicles.													
							in.	in.	ft.	in.	ft. in.	ft. in.	in.	
1	FWD 1½-ton Model G	3,000	—	—	36	4	56	124	46	—	16 8	11 4	36	multiple disc
2	FWD 3-ton Model B, 1915	6,000	6,000	12,000	36	6	56	124	46	70	16 8	11 4	36	,,
3	FWD 5–6 ton	11,000	10,000	21,000	38	6 dual	72	148	34.5	88	21 8	13 0	—	,,
4	Jeffery Quad Model 4016	4,000	*5,000*	*9,000*	36	5	56	124	24	74	16 10½	10 0	38	disc
5	Walter Super-quad 3-ton Model	6,000	*6,000*	*12,000*	40	6	64	132	15	82	18 6	11 6	38	leather cone
6	Walter Super-quad 5-ton Model	10,000	*6,000*	*16,000*	40	7	64	156	17.5	82	20 6	15 0	38	,,
7	Walter Super-quad Tractor	6,000	*6,000*	*12,000*	40	4 dual	64	108	12.5	79	16 6	9 0	38	expansion cone
8	Couple-Gear 3½-ton Petrol-Electric HC	7,000	*9,000*	*16,000*	36	3½ ,,	66	144	13.5	82	18 6	14 0	—	electric
9	Couple-Gear 5-ton Petrol-Electric AC	10,000	*11,000*	*21,000*	36	4 ,,	66	144	13.5	89	18 6	14 0	—	,,
10	Couple-Gear Electric 5-ton Model A	10,000	*11,000*	*21,000*	36	4 ,,	72	106	10	89	14 6	14 6	49	,,
11	Couple-Gear Electric 3½-ton Model H	7,000	*9,000*	*16,000*	36	3½ ,,	66	106	10	80½	14 6	14 6	43	,,

Approximate and estimated figures are shown in italics.

—	Make and Description.	H.P.	No. of Cylinders.	Bore.	Stroke.	1st Speed.	2nd Speed.	3rd Speed.	4th Speed.	Reverse Speed.	Foot-brakes. No. diam. Width.	Emergency Brake. No. diam. Width.	Water. Gallons (Brit.)	Petrol. Gallons. (Brit.)
	Engine.						**Speeds, Brakes, &c.**							
					in.	gear ratio.	gear ratio.	gear ratio.	gear ratio.	gear ratio.	No. in.	No. in.		
1	FWD 1½-ton Model G	28.9	4	4½	5	—	—	—*	—	—	8×1½	13½×2	—	—
2	FWD 3-ton Model B	36.1	4	4½	5½	35.6:1	17.8:1	8.9:1	—	36.1:1	10×3½	15½×2½	6.6	21
3	FWD 5–6-ton	44.2	4	5½	7	46:1	22.5:1	12.1:1	—	55.3:1	10×4	15.9×4	—	21
4	Jeffery Quad Model 4016	28.9	4	4½	5½	42.3:1	24.7:1	14.05:1	8.5:1	45:1	4×6½×2½	1×8×2½	9.2	22
5	Walter Super-quad 3-ton Model	30.6	4	4½	6	67:1	27:1	13.6:1	8.4:1	51:1	2×12×4	1×10×3½	—	25
6	Walter Super-quad 5-ton Model	30.6	4	4½	6	67:1	27:1	13.6:1	8.4:1	51:1	2×12×4	1×10×3½	—	25
7	Walter Super-quad Tractor	30.6	4	4½	6	67:1	27:1	13.6:1	8.4:1	51:1	2×12×4	1×10×3½	—	21
8	Couple-Gear 3½-ton Model HC	40	4	5	5½	25:1	—	—	—	25:1	4×17×2	electric	—	17
9	Couple-Gear 5-ton Model AC	40	4	5	6	25:1	—	—	—	25:1	4×17×2	,,	—	17
10	Couple-Gear Electric 5-ton Model A	18-h.p. battery of 44 cells 33 plates each				25:1	—	—	—	25:1	4×17×2	,,	—	—
11	Couple-Gear Electric 3½-ton Model H	9 ,, ,, ,, 17 ,,				25:1	—	—	—	25:1	4×17×2	,,	—	—

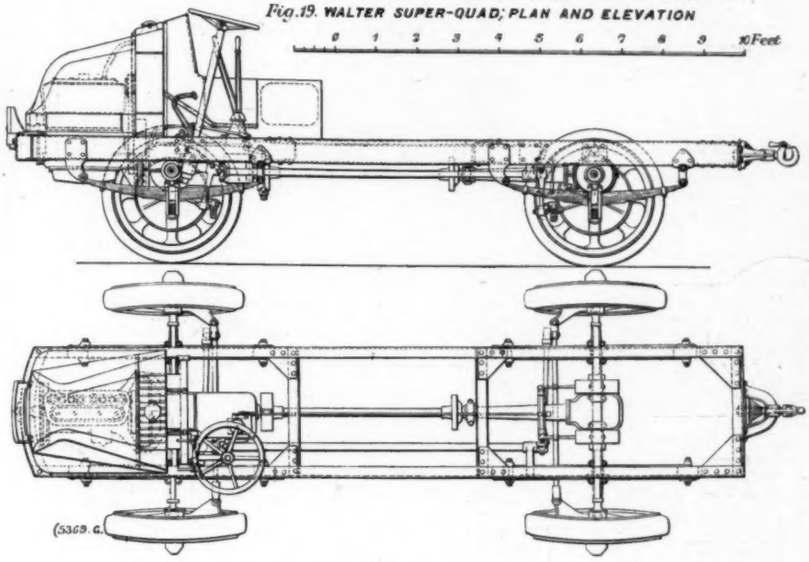
* Geared to 16 m.p.h.

* Paper read before the Institution of Mechanical Engineers, on Friday, January 18, 1918.

TRACTION ON BAD ROADS OR LAND.

(*For Description, see Page* 118.)

Fig. 19. WALTER SUPER-QUAD; PLAN AND ELEVATION



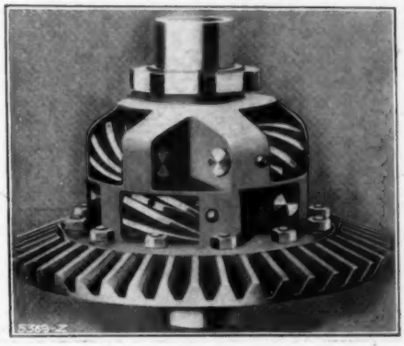


FIG. 25.

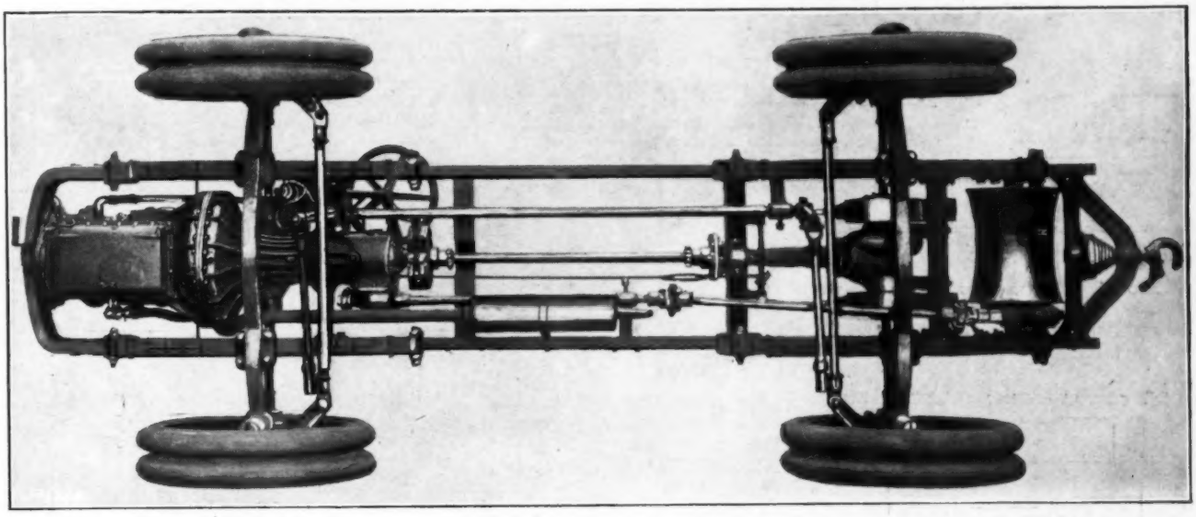


FIG. 23.

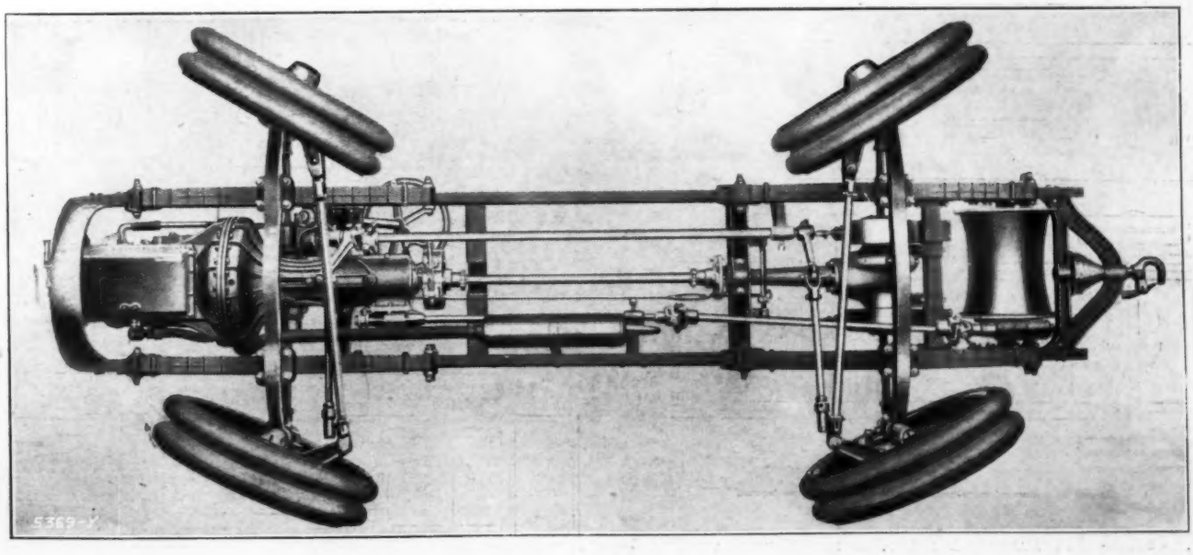


FIG. 24.

FIG. 19 AND FIGS. 23 TO 25. WALTER SUPER-QUAD CAR WITH FOUR-WHEEL DRIVE AND FOUR-WHEEL STEERING.

(*To face page* 118)

TRACTION ON BAD ROADS OR LAND.

(*For Description, see Page* 118.)

Fig.20. WALTER SUPER-QUAD: TRACTOR.

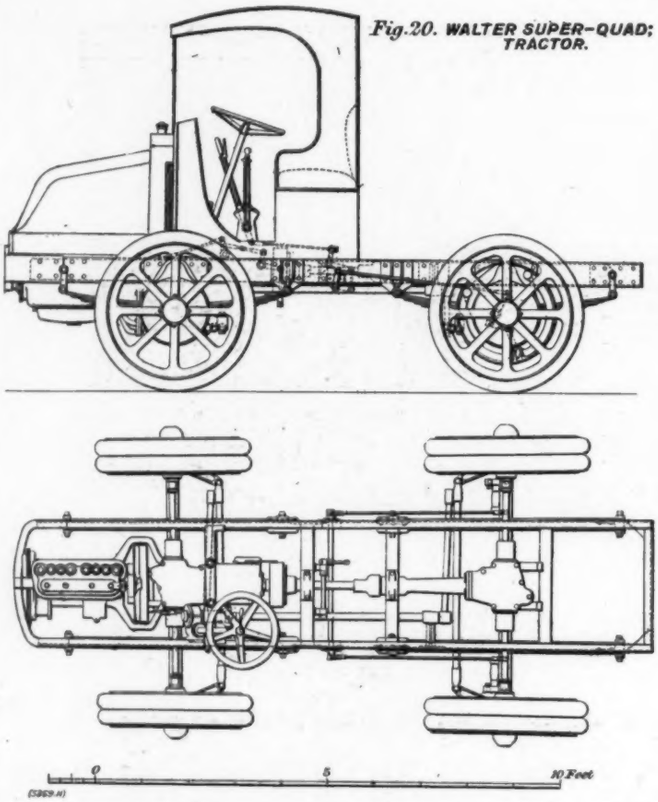
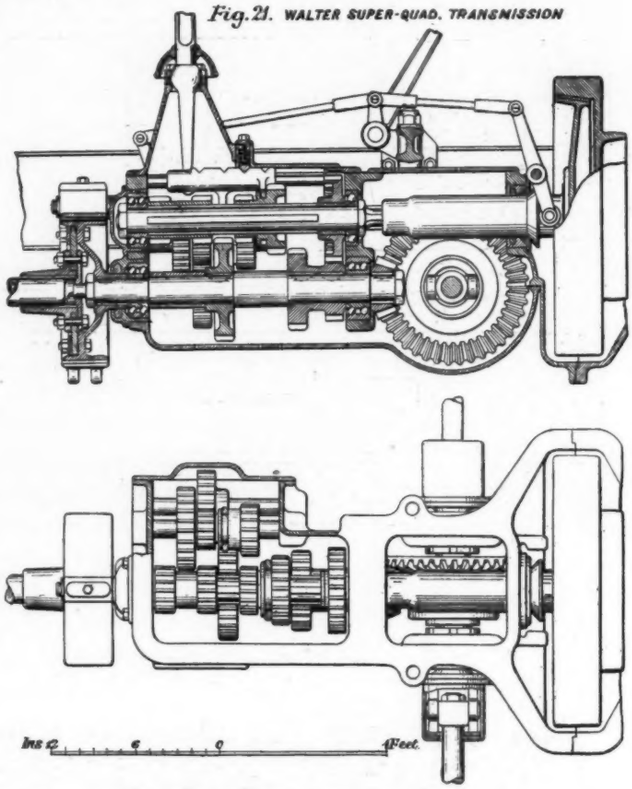


Fig.21. WALTER SUPER-QUAD. TRANSMISSION



FIGS. 20 AND 21. WALTER SUPER-QUAD CAR WITH FOUR-WHEEL DRIVE AND FOUR-WHEEL STEERING.

Fig.22. TRANSMISSION AND WHEEL-DRIVE.

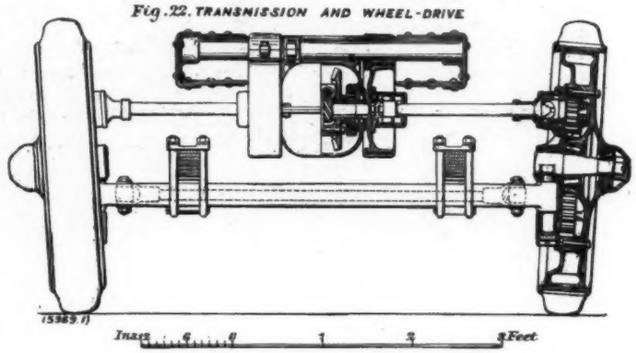


Fig.29. COUPLE-GEAR; ELECTRIC TRUCK

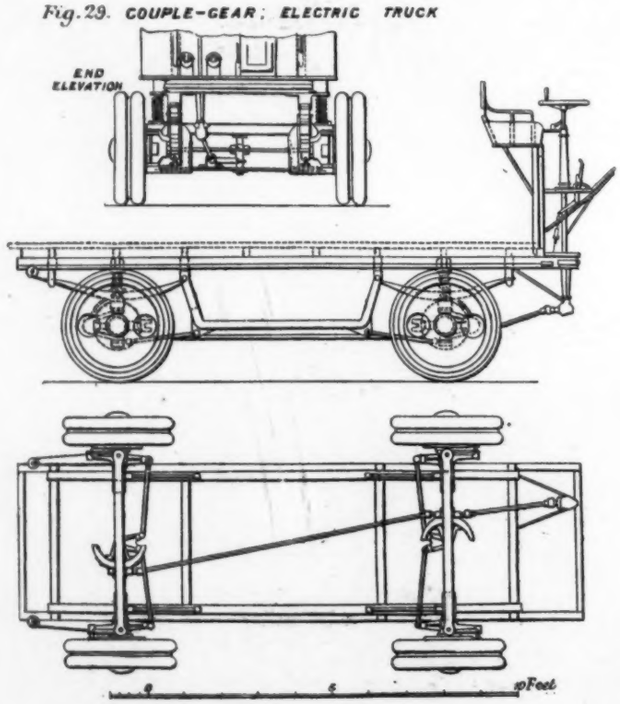


Fig.30. COUPLE-GEAR; PETROL ELECTRIC TRUCK

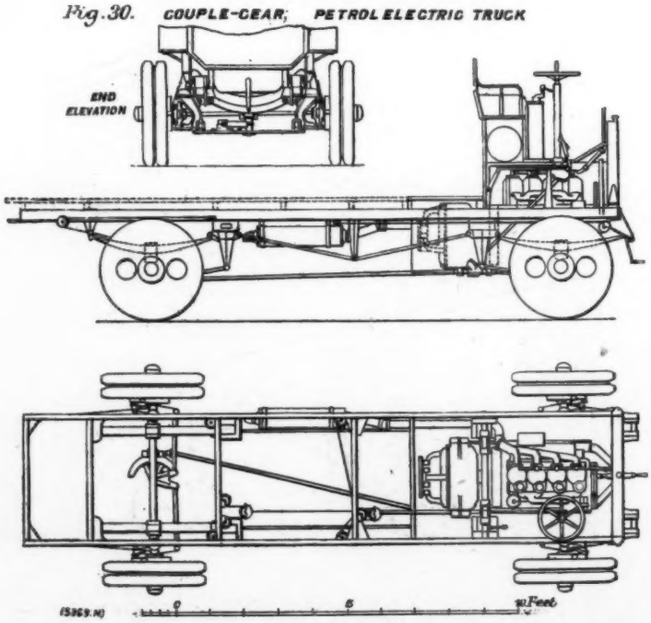


FIG. 29. COUPLE-GEAR BATTERY-DRIVEN ELECTRIC TRUCK, AND FIG. 30 PETROL ELECTRIC TRUCK BY THE COUPLE-GEAR FREIGHT WHEEL COMPANY, GRAND RAPIDS, MICHIGAN.

TRACTION ON BAD ROADS OR LAND.

(*For Description, see Page* 118.)

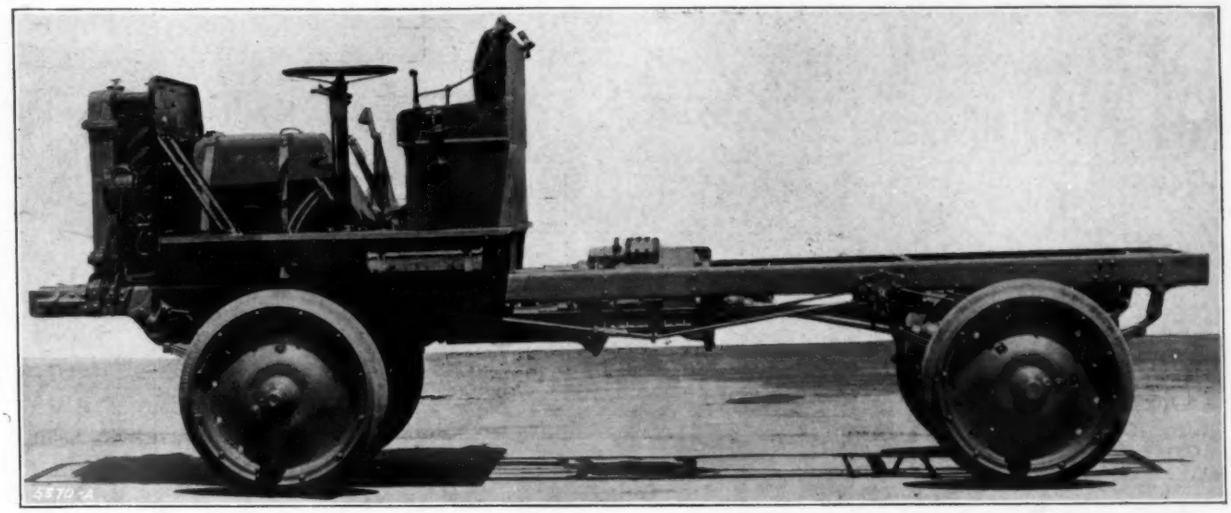


FIG. 26.

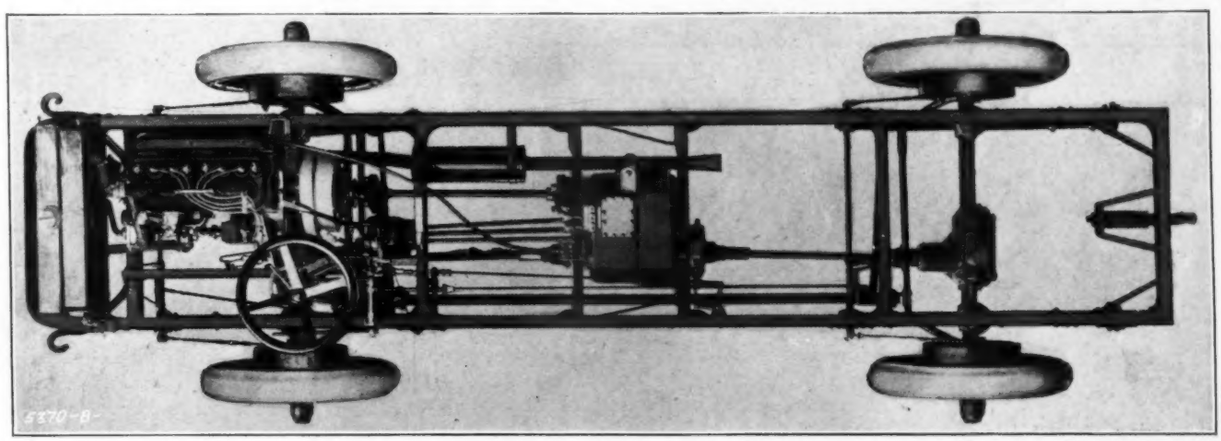
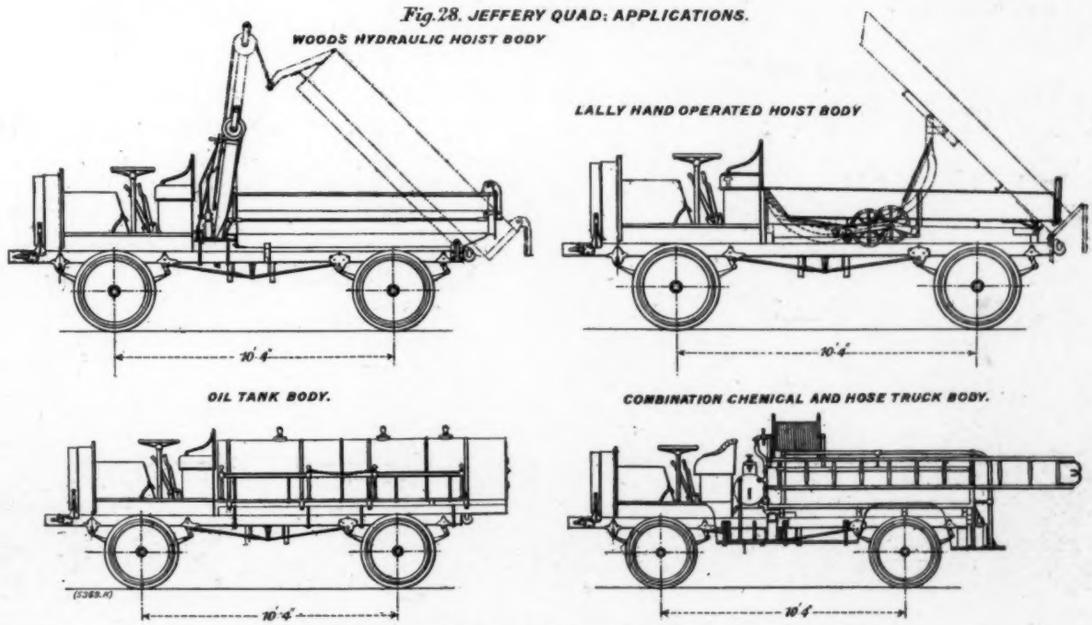


FIG. 27.

Fig. 28. JEFFERY QUAD: APPLICATIONS.



FIGS. 26 TO 28. THE JEFFERY QUAD CAR.

TRACTION ON BAD ROADS OR LAND.

(*For Description, see Page* 118.)

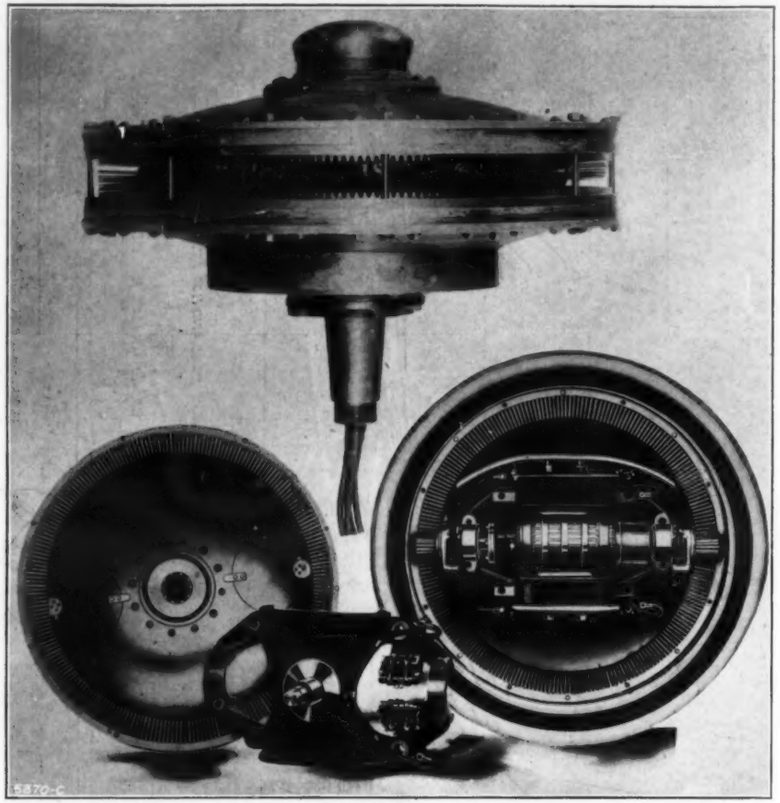


FIG. 31

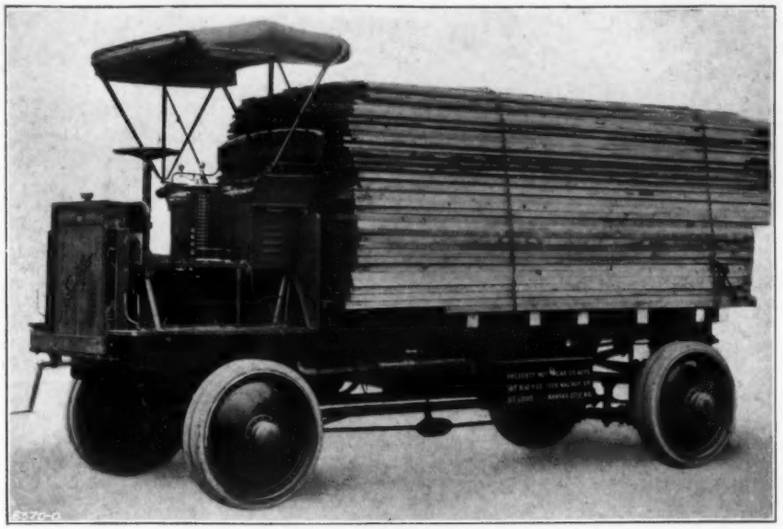


FIG. 32.

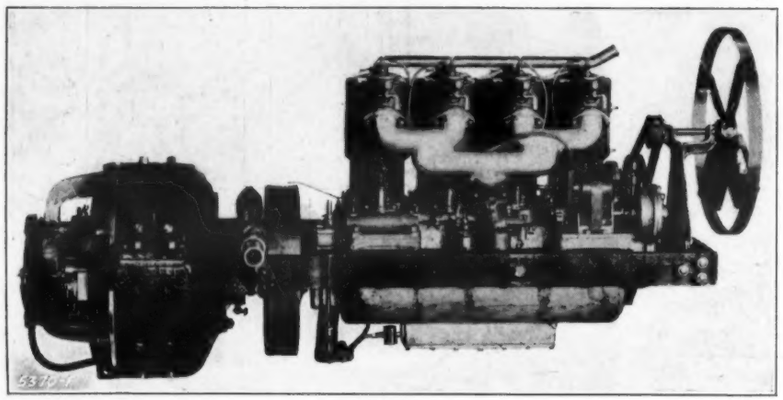


FIG. 35.

FIG. 36.

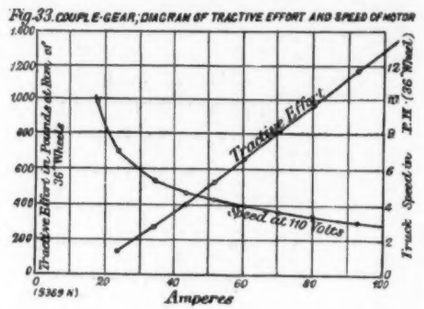


Fig.33. COUPLE-GEAR; DIAGRAM OF TRACTIVE EFFORT AND SPEED OF MOTOR
Tractive Effort in Pounds at Rim of 36 Wheels
Truck Speed in M.P.H. (36" Wheels)
Tractive Effort
Speed at 710 Volts
Amperes
(5369 A)

FIGS. 31 AND 32. THE COUPLE-GEAR BATTERY-DRIVEN ELECTRIC CAR.

FIG. 33. THE COUPLE-GEAR ELECTRIC CAR; DIAGRAM OF TRACTIVE EFFORT AND SPEED OF MOTOR.

FIG. 35. POWER PLANT OF COUPLE-GEAR PETROL ELECTRIC CAR.

FIG. 36. FIRE ESCAPE WITH COUPLE-GEAR DRIVING SYSTEM.

(*To face page* 119.)

motors. There is one brake of the contracting type to each wheel, and also an electric emergency brake.

To enable the vehicle to be driven over roads which present uneven surface or very unequal resistance to traction a special form of control is arranged. Current is supplied to the motors of the four wheels through a controller of the street-car type modified to suit the conditions. This controller has five contact points, two of which (the third and fifth in the battery car, and the fourth and fifth in the petrol-electric car) are arranged for what the makers term "parallel speeds," the motors being put in parallel when these contacts are made; thus, if one wheel slips it has no effect on the other three, or if two wheels slip there is no effect on the other two. The other three contacts are for what the makers term "building-up speeds"; on these points a sort of differential action is provided between the two groups of wheels taken diagonally on the car. The right front wheel and left back wheel form one group, and the left front and right back form the other group. When running on the third building-up speed a differential action occurs between the wheels of these groups, so that if one wheel of the group slips, its fellow will be left without power. If under these circumstances the slipping continues, and the driver of the vehicle moves the controller forward to the next contact, all the wheels are then put to work independently of each other.

It is stated that on a dry gravel road a tractive effort equal to 60 per cent. of the total weight of the vehicle can be obtained before the wheels begin to slip. This figure depends, of course, on the character of the road surface.

The accumulator-driven type of tractor is only recommended in cases where charging facilities are obtainable, and the total daily mileage does not exceed 40 miles. The petrol-electric vehicle is shown in elevation, front elevation and plan in Fig. 30, Plate X, and the power plant in Fig. 35, Plate XII. These vehicles are not only used as ordinary lorries, but in many instances are adapted with a pivotal carriage to take the front end of a trailer which may be a goods wagon, fire-escape, or electric-tramway tower wagon. In this application the vehicle is sometimes known as a semi-tractor. The Couple-gear driving system is also applied to two-wheel drive vehicles such as fire engines. Fire escapes are dealt with by two methods; either as a very long wheel-base vehicle, Fig. 36, Plate XII, or on the semi-tractor principle with a long trailing wagon.

Applications of Four-wheel Drive to Bad Roads or Land.—In the mining and agricultural districts of North America vehicles are required to negotiate long stretches of sand or mud. They are required to work on desert land, through sagebrush and among sand dunes, under such conditions as are illustrated by the views of F.W.D. vehicles given in Figs. 15 and 16, page 90 *ante*, and they may even be used to haul trains of tip-wagons on a light railway straddled by the tractor, Fig. 17, page 90. An end-tip wagon with hydraulic tipping gear is shown in Fig. 18, page 90.

The limitations in all these cases are defined by the engine power, transmission efficiency,* insistent load, wheel diameter, tyre width, weight of vehicle, and, when a trailer is hauled, the drawbar pull. There is no satisfactory method at present known for estimating the resistance presented by land, sand or mud, so soft that the wheels can sink to a depth of several inches, though it is known that the resistance under such conditions may be as much as 15 per cent. to 20 per cent. of the load. The illustrations must therefore be taken as the best method of affording some idea of the work that can be performed by four-wheel driven vehicles.

Comparative figures for the different types of vehicle, their horse-power, speeds, load, weight, wheel base track width, turning radius, and overall dimensions are, given in Table I, on the opposite page.

Conclusions.—For the transport of goods over bad roads on gradients, varying from 1 in 15 on roads in which the tyres sink 2 in. to 3 in. in depth to 1 in 5 on hard roads with bad surface, and for speeds varying from 1.5 m.p.h. on grades to 12 m.p.h. on fairly level roads, the four-wheel drive tractor has great advantages over the ordinary two-wheel drive tractor.

In the author's opinion it may be expected to rank as an important factor in the development of districts overseas not far removed from railhead, but having only primitive roads.

PART II.

Chain-Track Tractors.—The invention of the endless track or self-laying railway dates to nearly a century-and-a-half ago. The first mention of a scheme analogous to that now adopted in so many forms of tractors is the British invention of Richard Lovell Edgeworth (February 15, 1770) for a "portable railway" or artificial road to move along with any carriage to which it is applied. Although no drawings can be traced of the invention, the description given is remarkably clear and precise; in fact, almost unaltered, it applies to the greater number of chain-track tractors of to-day.*

The Motor Car Acts of 1896 and 1903, while affecting the restrictions on light locomotives, had little, if any, direct influence on the development of chain-track tractors. This type of vehicle owes its development to the very great difficulties presented to wheeled tractors by bad surfaces of road or land. The worst conditions are snow, ice, sand, clay and marsh. Of these snow and marsh have had most often to be faced, the former for the haulage of lumber in winter over snow and ice tracks in forest country, and the latter for the haulage of gang-ploughs through the marshy deltas of California and in the swampy country of Illinois and Wisconsin. The necessity for travelling over various kinds of land in moving from place to place has demonstrated the capacity of these vehicles for haulage across alkali and other deserts as well as over clay. To enable chain-track tractors to run on soft or swampy land the insistent weight has been reduced much below that imposed by a horse, which, carried on two feet as in walking, may exert a pressure on the ground of from 20 lb. to 25 lb. per square inch. In fact, many of these machines can be run safely over marsh in which a man would sink to his waist. The pressure exerted by a man when standing on the sole of one boot varies considerably, but may be taken as from 6 lb. to 7 lb. per square inch. Some of the chain-track tractors designed for soft ground have an insistent load of less than 4 lb. per square inch, while in others, specially designed for swampy country and fitted with tracks of abnormal width, this figure falls as low as 1.8 lb. per square inch. The difference between wheel loading and chain-track loading of soft ground is shown in Fig. 37, page 118.

Classification of Chain-Track Tractors.—The various track systems may be classified as follows:—

(*a*) Feet or sections laid by a wheel; the girdle form, of which Boydell's tractor, Fig. 38, the ordinary girdle, Fig. 39, and the early Pedrail,† Fig. 40, are examples.

(*b*) Chain-track supporting rollers with axes fixed relatively to the truck frame by which they are carried; examples of this are the caterpillar (Holt), Fig. 47, annexed, Creeping-Grip (Bullock), Fig. 41, Tracklayer (C. L. Best), Clayton, Strait, Burford-Cleveland, and others.

(*c*) Chain track supporting through secondary chains

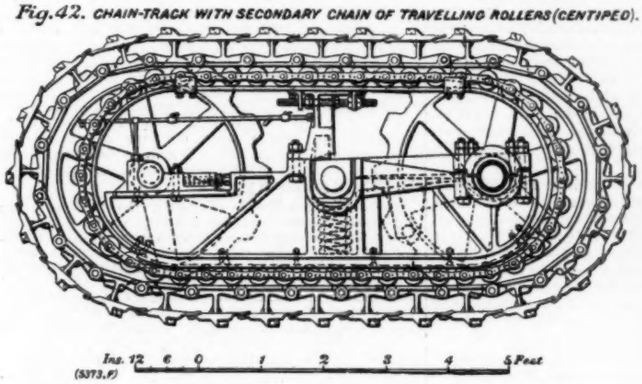


Fig. 42. CHAIN-TRACK WITH SECONDARY CHAIN OF TRAVELLING ROLLERS (CENTIPED).

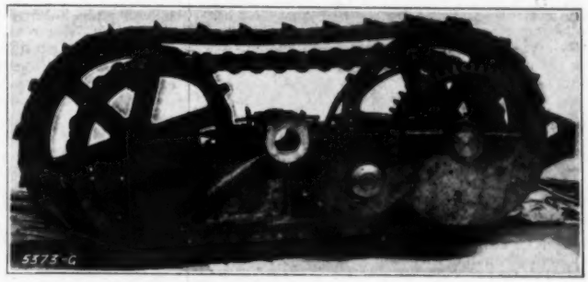


FIG. 43. CENTIPED PHŒNIX PETROL TRACTOR.

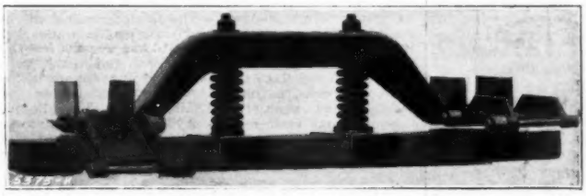


FIG. 44. NEW FORM OF DIPLOCK PEDRAIL.

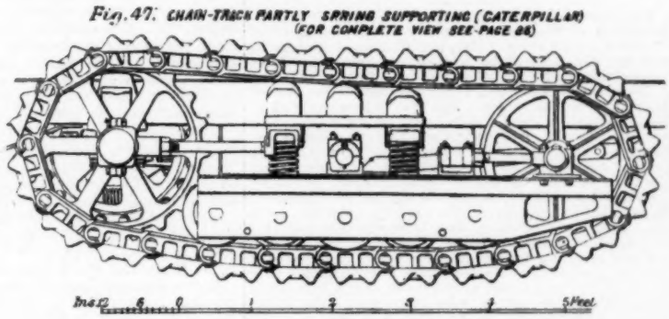


Fig. 47. CHAIN-TRACK PARTLY SPRING SUPPORTING (CATERPILLAR) (FOR COMPLETE VIEW SEE PAGE 88)

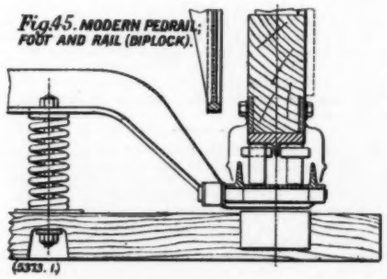


Fig. 45. MODERN PEDRAIL: FOOT AND RAIL (DIPLOCK).

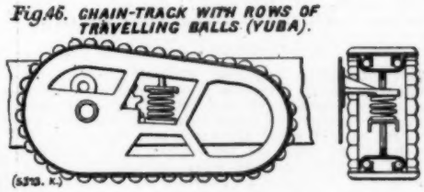


Fig. 46. CHAIN-TRACK WITH ROWS OF TRAVELLING BALLS (YUBA).

* The efficiency of gear-box and bevel transmission does not appear to have been investigated thoroughly. The author believes that in vehicles of the types described it amounts to about 85 per cent. of the engine brake horse-power. Proceedings Inst. of Automobile Engineers, vol. iii, pages 357 *et seq.*

* See Historical Note in Appendix I.

† Proceedings, I.Mech.E., 1910, pages 1,561 to 1,566.

of travelling rollers arranged as intermediate chains between the truck or sledge, and the track or lag chain; examples of this are the Log-Hauler (Phœnix) steam tractor for snow and ice, Fig. 42, also Fig. 43, annexed the Centiped (Phœnix) petrol tractor for soft ground, Fig. 70, the Allis-Chalmers, Fig. 73, and the modern form of Pedrail (Diplock), Fig. 54, to be given later.

(*d*) Chain-track supporting by rows of travelling balls, as in the Ball-Tread (Yuba) tractor, Fig. 46.

Apart from the girdle, sometimes fitted to hauled vehicles, there is no modern representative of extended application of tractors of Class (*a*) known to the author.

The chain-track tractors that are constructed and used in the largest numbers, both as to makes and output, are those with rollers revolving on axes fixed to one or more truck frames for each track, Class (*b*).

It appears that chain-track tractors for the haulage of lumber were made and used commercially in the United States as early as 1904, and some of these early tractors are stated to have been still at work last year; these vehicles are fitted with the intermediate roller chains of Class (*c*).

Tractors in which the load is transferred from the chain to the track frame by rows of travelling balls, Class (*d*), are represented at present, so far as the author is aware, by the single example of the Ball-Tread (Yuba).

(*To be continued.*)

Improving Cast-Iron with Uranium.—By alloying uranium with cast-iron or semi-steel, the strength and toughness of the metal is increased, as well as the fluidity, according to a patent (U.S. 1,247,252, November 20, 1917) granted to Joseph M. Flannery, Pittsburgh, and consigned to the Standard Chemical Company of that city, says *The Iron Age*. The quality of the iron for machinery is claimed to be enhanced and the resistance to wear increased. The new alloy is made by adding uranium to the molten iron as uranium metal or as ferro-uranium, so that the finished product will contain from 0.05 per cent. to 1 (0.1?) per cent. of uranium. The addition of this element is said to deoxidise and denitrogenise the metal, increasing the tensile strength and producing a fine-grained product.

Submarine Construction in the United States.—According to *The Iron Trade Review*, Cleveland, Ohio, for December 27, the first rivet was driven on December 20 into the first keel to be laid by the Submarine Boat Corporation, at its new Government shipbuilding plant at Port Newark Terminal, N.J. The boat is the first of fifty 5,000-ton steel craft. The first boat is expected to be completed by June 1 next. Mr. Henry R. Sutphen, vice-president of the corporation, who presided at the laying of the keel, said: "Forty-six plants are turning out the structural steel to be used in these boats, and hundreds of other plants are rushing other parts, all standardised and ready to go into any one of the boats." In addition to the contract for the fifty 5,000-ton units, the corporation recently took a second contract for one hundred 7,500-ton boats. Twelve of the 28 ways are now ready for the laying of keels and the others are nearing completion. As the hulls are completed and launched they are towed to the docks of the Submarine Boat Corporation, half a mile away, where the inside work is carried out and the turbines installed.

Tin-Plating with Coke-Oven Gas.—We read in *The Iron Age* that an installation of 22 furnaces utilising coke-oven gas having a heating value of about 525 British thermal units has been made by the Surface Combustion Company, Long Island City, N.Y., at the Baltimore sheet and tinplate plant of the Bethlehem Steel Company, Sparrows Point, Md. Each furnace consists of a firebrick setting built around a cast-iron pot or bath of special design. All the burners operate on the high-pressure system with single-valve control and one pipe for distribution. The gas is supplied to the plant at a pressure of about 10 lb. per square inch, which eliminates all blowers and compressors. The burners are of the impact type and heat refractory beds in the combustion chamber. This chamber is located under that portion of the pot where the cold sheets are fed into the bath, and the burners supply all the heat needed for normal operation. In a test made of the installation, 7,850 lb. of steel sheets were coated at a temperature of 650 deg. F. in 8 hours. The amount of gas consumed was 5,376 cub. ft., having the above-mentioned heating value.

Fence Wire Corrosion.—The following is the summary of a paper by Mr. Oliver W. Storey, read before the American Electrochemical Society and reproduced by *The Iron Age*. The durability of old steel fence wire is due to the presence of copper. Manganese does not increase the corrosion of steel and its absence does not decrease the corrosion. The copper in the early steel and wrought iron came from the copper-bearing ores of the Eastern United States and imported ores. The proportion of copper steel made decreased with the increasing importance of copper-free Lake Superior ores. Steel fence wire containing copper is as durable as wrought iron. Present-day steel fence wire usually does not contain copper, and therefore corrodes rapidly. Under ordinary atmospheric conditions, zinc corrodes more slowly under conditions favouring rapid corrosion of iron, and, *vice versa*, iron corrodes more slowly under conditions favouring rapid corrosion of zinc. The life of fence wire is dependent upon the quality of both the galvanising and iron or steel base. Since the galvanising is usually thin, the life of the fence depends principally upon the iron or steel base, which should be highly resistant to corrosion.

COMMITTEE ON NEW ENGINEERING INDUSTRIES.

The Minister of Reconstruction, Dr. Addison, has appointed a committee of manufacturers and business men to consider the provision of new industries for the engineering trades. The duties of the committee will be to compile a list of the articles suitable for manufacture by British engineers, the articles being those which were either not made in the United Kingdom or were made in insufficient quantities and for which there is likely to be a demand after the war. The list is to be classified in three groups: articles that can be made (1) by women, (2) by men and women, (3) by skilled men, and is to show the industries to which such new manufactures could most suitably be attached. The committee is also to make recommendations as to the establishment and development of these new industries by the transfer of labour or machines or by other measures; also as to how such transfer could best be made and what organisation would be needed for the purpose with due regard to securing the co-operation of labour. To give help on this side of the work a Labour Advisory Panel is being formed, consisting of representatives of skilled, semi-skilled and unskilled workers, and of women. With this panel the committee will work in co-operation on questions concerning labour.

The need for such a list of articles and for some organised effort to make them at home has been amply shown by the war, which revealed our dependency on many countries, even the enemy, for articles vital to our industries and even to our war equipment. "Rush" orders to many countries were necessary before we could obtain them, and but for these special efforts and for favourable circumstances which enabled us to import these articles we should have had to go short. The committee has already covered some of the preliminary ground of its inquiry, and lists of imported engineering articles have been compiled from information supplied by merchants, trade associations and others. The lists embrace hundreds of articles ranging from the largest engineering tools down to smallest accessories. It will be for the committee to inquire as to which of all these articles may with advantage be made at home, having regard to all the conditions and considerations governing their manufacture.

The committee consists of the following: The Hon. H. D. McLaren, M.P., C.B.E. (chairman); Mr. Ch. Bennion (the British United Shoe Machinery Company); Sir George Bullough, Bart. (Messrs. Howard and Bullough); Mr. F. H. Crittall (the Crittall Manufacturing Company); Mr. R. Dumas (the British Thomson-Houston Company); Mr. W. B. Lang (Messrs. John Lang and Sons); Mr. C. A. Lister (Messrs. R. A. Lister and Co.); Mr. P. J. Pybus (the Phœnix Dynamo Manufacturing Company); Mr. G. H. Sankey (Messrs. Joseph Sankey and Sons, Limited); Sir Percy Stothert, K.B.E. (Messrs. Stothert and Pitt); Mr. J. Taylor (Messrs. Mather and Platt); Mr. W. Taylor (Messrs. Taylor, Taylor and Hobson); Mr. W. Thom (Messrs. Yates and Thom); and Sir W. Rowan Thomson, K.B.E. (Messrs. David Rowan and Co.).

Shipbuilding in Denmark.—Several new or much enlarged provincial shipyards in Denmark seem to be framing for a considerable business. Thus the steamer Company Hamlet has taken over three contracts for steamers, each of about 2,400 tons d.w., being built at the Svendborg yard, the price being about 5,000,000 kronen. The Rödby Harbour yard has sold three motor schooners of 2,100 tons d.w., each to the Steamer Company of 1915; the price is 1,250,000 kronen each. The building of these vessels will be proceeded with as quickly as the supply of raw materials will allow.

Fresh Coercive Syndicate Threats in Germany.—The Ministry for Commerce and Industry has given notice to the owners of lignite deposits and industries in the Halle and the Breslau mining districts east of the Elbe, that they must form a syndicate for the production and sale of their lignite, briquettes, &c., before February 28, 1918. This decree, which is understood to have come as a surprise to those it concerns, particularly refers to the following lignite deposits: Niederlausitz, Oberlausitz, Görlitz and Frankfort-an-der Oder. There had been some connection between the three first mentioned deposits, but there were also separate unions, more especially as regards the important Niederlausitz area; and some lignite concerns, controlled by the Ignaz Petschek firm, have started lawsuits against the Niederlausitz combine, for the purpose of having the Niederlausitz Briquette Selling Company declared illegal. In order to arrive at a voluntary syndicate, which will no doubt be attempted, an arrangement will not only have to be arrived at with the Petschek concern, but also with the Ilse Mining Company, which, several years ago, left the existing incomplete syndicate. Arrangements will have to be made also with the lignite undertakings on the right bank of the Elbe. The Ilse Company has an annual production of 180,000 wagon-loads, the Petschek concern one of 230,000 wagon to 250,000 wagon-loads, and the rest about 300,000 wagon loads per annum.

NOTES FROM THE NORTH.

Glasgow, Wednesday.

Scotch Steel Trade.—The only limit to production in the steel trade at the moment is the difficulty of obtaining sufficient supplies of the necessary raw material, and that notwithstanding the greatly increased facilities for its production locally. Greater activity could scarcely be imagined than that prevailing in every steel-making establishment, for the mills run unceasingly and all the available labour is employed on the production of shell bars for the munition works and the shipbuilding material required for the yards entrusted with the Shipping Controller's contracts. It is continuous activity all along the line. Unfortunately, the questions affecting labour are meantime proving rather disconcerting to the workers, but everything possible is being done to prevent any untoward happenings. With the home demands for steel so very brisk and so very important, export has less chance than ever, some small shipments for the French and the Italian Government representing the entire overseas trade at the present time.

Malleable Iron Trade.—The malleable iron trade is just as intensely busy as are the other industries engaged on war work, the tension on masters and men alike being abnormal and the entire plant running at full pressure. While there is a keen demand for every size, perhaps small rounds are most urgently required of any. Were conditions easier, the export trade could be greatly increased, for orders from overseas consumers are numerous and urgent, but the makers find themselves unable to meet the present heavy demands. No change in price has yet taken place.

Scotch Pig-Iron Trade.—Naturally the ever-increasing activity in the steel-making industry makes additional and very pressing demands upon the pig-iron trade, the demand for the consumption of hematite being considerably in advance of anything hitherto experienced. Under these circumstances nothing but class "A" work can now be undertaken. Export is, meantime, a "dead letter," for nothing remains after the local requirements have been met. Although rumour has it that Government proposes giving a subsidy of 20*s.* per cwt. to pig-iron smelters on account of the increased cost of fuel, nothing definite has yet been announced, and considerable anxiety is felt as to the ultimate course of events.

German War Profits.—The Metallgesellschaft in Frankfort has last year earned gross profits amounting to 9,525,502 marks, against 8,816,893 marks for the previous year, but general expenses and taxes were more than doubled, so that the net profits, amounting to 6,960,513 marks, fell somewhat short of the figure for the previous year, 7,142,829 marks. The board, managers and staff receive 2,276,300 marks as their share in the profits, and gratuities: the dividend was again 25 per cent.

Tax on Yachts in the United States.—An annual excise tax on all yachts, pleasure power and sailing boats, of over 5 tons net, says *The Marine Journal*, New York, is included in the War Revenue Act as follows: All boats of 5 tons and having a length of not over 50 ft. overall, 50 cents for each foot; length over 50 ft. and not over 100 ft., 1 dol. for each foot; length over 100 ft., 2 dols. for each foot; motor boats of not over 5 tons net, with fixed engines, 5 dols. Forms of instructions have also been issued to collectors of customs for the protection of pleasure vessels of 5 tons and under, and owners of such should apply to the admeasurer of vessels, in order that the certificate which protects them may be issued.

The Electric Furnace Capacity of Canada.—At the ninth annual meeting of the Commission on Conservation at Ottawa, reports *The Iron Trade Review*, Cleveland, Ohio, Sir Clifford Sifton, chairman, announced that an interesting investigation had been made regarding the development of the electric smelting problem. At the present time, he stated, there are in Canada 32 Héroult electric furnaces and 22 of other types—in all 54. These furnaces have a capacity of 173,000 tons of iron and steel, 50,000 tons of ferro-silicon and 8,000 tons of other ferro-alloys per year. The British forgings plant at Toronto has 10 Héroult electric furnaces, with a total annual capacity of about 72,000 tons, which make it one of the largest electric furnace plants in the world.

Association of Engineering and Shipbuilding Draughtsmen.—A gathering of the members of the Merseyside Branch, Engineering and Shipbuilding Draughtsmen's Association, was held on Saturday last at the Angel Hotel, Liverpool. Mr. J. D. Murray, president of the branch, occupied the chair, and in the course of his remarks gave an interesting account of the Delegates Conference recently held in Manchester. Mr. D. Spencer, vice-president, referred to the gratifying increase in the membership, and dealt with the excellent work done by the Merseyside branch. A short address was given by Mr. J. E. Jolley, secretary of the Manchester branch, who spoke of the magnificent progress made by the association in their efforts to advance the interests of the profession. He pleaded for a level-headed, but vigorous policy, and pointed out that the success of the association depended entirely upon each man doing his utmost for the cause at every available opportunity. An excellent musical programme was given under the direction of Mr. Percy Dalziel. It was announced that a series of lectures would be given during the remaining winter months under the auspices of the Merseyside branch.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

A Worthy Record.—Sheffield suffers a serious loss in the departure from its midst of Mr. John Little, for the past ten years general manager of Messrs. Cammell Laird and Co.'s Grimesthorpe works, and one of the best-known figures in engineering circles in the city. Mr. Little has accepted the onerous position of representative of Cammell Laird and Co. in the Liverpool and Manchester districts, with offices in the latter city. It is now some forty-two years since he entered the service of the company as office boy at the age of 13. Passing through the pattern shop and drawing office, on attaining his majority, he was transferred as a draughtsman to the company's Penistone works. In 1886 he returned to Sheffield, and when the Dronfield steel works were transferred to Workington was sent to the latter town, where he executed the designs for considerable extensions and additions. In less than a year he was back in Sheffield as assistant chief engineer, and in 1902 was promoted to the position of chief engineer, with the full responsibility for the company's various properties. That post he held until his appointment to the general managership of Grimesthorpe works. From an engineering point of view, Mr. Little has been closely allied with the manufacture of armour plates from the early days of the old iron plate, through the various stages of improvement, right up to the present date. He was responsible some fifteen years ago for the laying down of one of the largest armour plate-making plants in the world. Always of studious habits, in his younger days he won a free studentship in the School of Art, qualified, and became a teacher. In later years he was one of the founders of the Sheffield branch of the Junior Institution of Engineers, for two years president and occupying a seat on the council of the Sheffield Society of Engineers. He is now in his second year of presidency of the Sheffield branch of the British Foundrymen's Association and junior vice-president for England.

Iron and Steel.—The city is still feeling the effects of the recent stoppage. Material is not yet coming forward with freedom, and the production of finished goods is being retarded. The output of steel is a steadily progressing one, but the same cannot be said of raw material, which, with the growing demand, is becoming increasingly difficult to procure. All qualities of scrap are eagerly bought up at top prices. Rolling mills and forges are working full time. For both high-speed and crucible steel there is a brisk demand, and the output is only limited by the shortage of labour and alloys. Tools of all descriptions find a ready market, most of the makers being booked far ahead, while the requirements of the country are considerably in excess of the supply. A branch of local industry which has increased by leaps and bounds since the commencement of the war, is the supply of shear blades for cutting steel and iron plates and large billets. These blades are necessarily of a very powerful character and of the finest steel, some having been turned out over ¼ ton in weight. Many are for the home market, but considerable consignments have also been sent to France and Italy. There is a full supply of Swedish material, but prices are almost prohibitive, and contracts are only being renewed for short periods. The export trade is a diminishing quantity. New articles continue to be placed on the prohibited list, and permits to ship are only granted when an exceptionally good case is made out. All this tends to divert business from this country to the United States, which, agents state, are securing many markets formerly supplied by Europe.

South Yorkshire Coal.—There is little fresh in the position of the coal market, business being decidedly on the quiet side. In best steam hards, when the demand of the railway companies, blast and converting furnaces has been satisfied, there remains practically nothing on the open market. Cobbles, nuts and slacks are going away freely on contract account, and great difficulty is found in securing a sufficient tonnage, especially of the middle quality of nuts, for the munition works. Where in normal times slacks would be used, working under the present high pressure it is found advisable to use nuts, causing a great shortage of these qualities. In house coal the collieries are still under Controller's orders for heavy supplies for the Metropolitan area, and this is seriously affecting the provincial markets. Sheffield is in a fairly strong position, but the Eastern Counties and South of England are suffering from a distinct shortage and only able to meet requirements from day to day. Cokes of all descriptions are fairly held. Prices are at the maximum. The heavy demand for steel works and pig-iron furnaces is aggravated by the general difficulty of dealing with traffic. Quotations:—Best branch hand-picked, 23*s.* to 24*s.*; Barnsley best Silkstone, 23*s.* to 23*s.* 6*d.*; Derbyshire best brights, 21*s.* to 22*s.*; Derbyshire house coal, 18*s.* 6*d.* to 19*s.* 6*d.*; best large nuts, 16*s.* 6*d.* to 19*s.* 6*d.*; small nuts, 17*s.* 6*d.* to 18*s.* 6*d.*, Yorkshire hards, 18*s.* 6*d.* to 19*s.* 6*d.*; Derbyshire hards, 17*s.* 9*d.* to 18*s.* 9*d.*; best slacks, 14*s.* to 14*s.* 6*d.*; seconds 13*s.* to 13*s.* 6*d.*; smalls, 9*s.* to 10*s.*

GERMAN CARGO STEAMER.—One of the world's largest cargo steamers is reported to have been launched from the Vulkan yard, Bremen, named *Rheinland*, built for account of the Hamburg-America Steamer Company the principal dimensions are, length 150 m., (492 ft.), breadth, 19½ m. (64 ft.), and depth 12½ m. (41 ft.). The loading capacity is 16,000 tons. The engines are to be internal combustion engines, and the vessel's double bottom has been built in compartments to serve as oil bunkers. The speed will be about 13 knots, and all loading and discharging appliances will be of the most approved type.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—A good deal of business is passing in Cleveland pig-iron. The issue of February allocations has brought home buyers into the market, and deliveries are now on a fairly satisfactory scale, the inconvenience caused by shortage of trucks having been overcome to some extent by despatch of supplies by lighter. Some of the furnaces are stated to be working very irregularly, with the result that they are producing a rather large proportion of the inferior qualities of iron. Some producers, however, have fairly good stocks of foundry iron, and are in a position to meet the pressing needs when sufficient labour is available, and more ample means of transit are provided. The claims upon transport services are unprecedented. Both makers and merchants are adapting themselves to the situation as well as circumstances will permit. Export trade is governed by the question of tonnage. For home consumption, No. 3 Cleveland pig-iron, No. 4 foundry and No. 4 forge all stand at 95*s.*, and No. 1 is 99*s.*; and for shipment to France and Italy, No. 3 and the lower qualities are all quoted 116*s.*, and No. 1 119*s.*

Hematite Iron.—In the East Coast hematite department the situation is as stringent as ever, and after minimum home needs have received attention very little surplus iron is left for disposal abroad. Nos. 1, 2 and 3 are 122*s.* 6*d.* for home use, and 147*s.* 6*d.* for export to France and Italy.

Foreign Ore.—Increased cost of production, adverse rates of exchange, and higher insurance rates have caused dissatisfaction with prices of foreign ore, and it is understood that these considerations have been recognised by the Ore Control Committee, and that an advance of half a crown per ton on base rates has been authorised.

Coke.—There is a large business passing in coke. Demand on home account is very heavy, but inquiry from abroad shows some falling-off. For home consumption foundry cokes are 38*s.*; average blast-furnace kinds 33*s.* at the ovens, and qualities low in phosphorus 35*s.* 6*d.* at the ovens; whilst for shipment to neutrals foundry descriptions are 45*s.* f.o.b., and gashouse product 38*s.* to 40*s.* f.o.b.

Manufactured Iron and Steel.—While finished iron and steel manufacturers are fully employed as ever on execution of Government orders, and production of material for the shipyards, little opportunity is afforded for the transaction of business in other directions. Prices, all round are stiff. Principal market quotations to home customers stand:—Common iron bars 13*l.* 15*s.*; best bars, 14*l.* 2*s.* 6*d.*; best best bars, 14*l.* 10*s.*; iron ship plates, 15*l.* 10*s.*; iron ship angles, 13*l.* 15*s.*; iron ship rivets, 19*l.* 10*s.*; packing iron and steel (parallel), 13*l.* 10*s.*; packing iron and steel (tapered), 15*l.* 15*s.*; steel bars (no test), 15*l.*; steel ship plates, 11*l.* 10*s.*; steel ship angles, 11*l.* 2*s.* 6*d.*; steel boiler plates, 12*l.* 10*s.*; steel joists, 11*l.* 2*s.* 6*d.*; and heavy steel rails, 10*l.* 17*s.* 6*d.*

ALLEN WEST ENGINEERING SOCIETY.—The usual fortnightly meeting of the above society was held in Brighton on Tuesday, January 22, when a lecture was given on "Auxiliary Machinery of Rolling Mills," by Mr. James Calderwood, of Messrs. Wellman Seaver Rolling Mills, Limited. The lecturer dealt with the design and construction of such auxiliaries as screwdown gear, manipulators, live roll, &c., and in the course of his remarks traced the course of an ingot through the blooming rolls and finishing rolls to the hot saws. Descriptions of the rolling of round bars and of a rail curver, were also given. The objects of the society are primarily for the instruction of the staff and foremen of Messrs. Allen West and Co., Limited; a number of their customers and friends residing within easy reach of Brighton were invited.

FABRICATION OF SILICA BRICKS.—In continuation of their researches on silica bricks Henry le Chatelier and B. Bogitsh (*Comptes Rendus*, November 26, 1917) describe some experiments, partly made in different works, on the suitable grain size and other points; further communications are to follow. Silica bricks must contain a certain amount of coarse particles to prevent the small cracks from spreading; but these particles, it is pointed out, should not exceed dimensions of 5 mm. On the other hand, only the finest quartzite (impalpable powder of 0.01 mm.) will dissolve and form the réseau, the magma, to which Le Chatelier attaches great importance. He finds that 25 per cent. of slime from gold mines, 75 per cent. of coarser quartzite of 4 mm., and further two parts of lime are a good mixture which promises a high crushing strength at ordinary temperature and at 1,600 deg. C.; too much slime favoured the formation of cracks. Very little, if anything, was gained by shaping the bricks, not by hand but under a pressure of 200 kg. per square centimetre. The substitution of "grog" (from old bricks) for the coarser quartzite secured no advantage either; the strength was rather lowered. When six parts of clay were used in the place of two parts of lime, the strength was still further reduced; such bricks, however, did not break down suddenly when tested at 1,600 deg. C., as the other bricks did, but yielded gradually. This is considered an important point. The experimental conditions and conclusions seem to indicate that some of the experiments were made at the Usine des Dunes by Philippon (see page 92 *ante*).

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Local Market.—The number of pits idle this week is slightly below the average of the past few weeks, but collieries are still experiencing great difficulties and these difficulties are aggravated by the altered character of the bunker trade, and by what is considered to be the arbitrary way in which the Government regulations are administered. The insistence of the authorities on the shipment of large coal for bunkers for the services of requisitioned tonnage has reduced considerably the market for through coals, and the pits producing descriptions which under normal conditions are mixed for bunker consumption are feeling the effects very acutely. The small coal problem, too, is very acute. Another unfavourable circumstance is the continued refusal of licences for the shipment of coke, and the commandeering of foundry qualities for blast furnace consumption at furnace coke prices. The Coal Controller has fixed definite prices of 50*s.* 6*d.* for foundry and 37*s.* 6*d.* for furnace coke, but without regard to these directions it is asserted that there is an official insistence on the delivery of some best foundry coke in the market at the bottom of these two prices.

Newport.—Business in Newport coals continues very restricted, but collieries in both the Eastern and Western Valleys of Monmouthshire are this week working fairly full time. Deliveries, however, are practically entirely under contracts, and only very few fresh transactions are reported. The strike at the Oakdale and Waterloo pits of the Tredegar Company is still unsettled. The pumpmen and hauliers have been induced to return to work to facilitate the bringing of the horses to the surface. Mr. E. S. Tallis, the general manager, however, is in negotiation with the workmen's representatives, and it is expected that a settlement will soon be effected.

Welsh Miners and the War.—A conference of delegates representing the South Wales Miners was held at Cardiff this week, and this afforded an opportunity for the formulation of a new programme. In regard to the man-power proposals of the Government it was decided that the South Wales delegation to the National Miners' Conference should support a proposal for taking a general ballot throughout the country, the following to be the form of ballot:—(1) Shall the Miners' Federation of Great Britain agree to the withdrawal of 50,000 men from the mines for military service, with a further 50,000 in reserve for future contingencies? (2) If so, shall the Federation machinery be used for the purpose of finding the required number.

The Question of Short Time.—The Coal Controller has intimated to the officials of the South Wales Miners' Federation that he is unable to agree to the proposal for the general application of the principle of curtailing the working week to five days as a means of mitigating the evils of irregularity of working at some of the collieries. At the Miners' Conference, on Monday, however, the demand for a five-day working week was reiterated. A resolution was passed authorising the council to continue the negotiations with the Coal Controller in the matter of short time and inequality of working at the collieries. The conference expressed itself as being "still of the opinion that the limiting of the working days to five per week will secure a more equitable distribution of the trade available without any detrimental effect upon the supply of coal for all purposes."

LIQUID FILMS—ERRATA.—A few mistakes crept into our notice of Sir James Dewar's discourse on pages 98 and 99 of our issue of last week. The internal pressure in the soap bubbles were actually given in mm. of water—not of mercury; the large black bubble had a surface of half a square metre, not a diameter of 0.5 m.; and Francis (not Roger) Bacon said that he who could comprehend the properties of matter—not of water—could comprehend all, &c.

NORWEGIAN SHIPBUILDING ON THE PACIFIC COAST.—The Norway Pacific Shipbuilding Corporation is the style of a new concern which is being founded on the Pacific Coast at Everett, in the State of Washington, some 30 miles from Seattle. The capital is Norwegian, and the company owns a site of 40 acres, where both building slips and a dry dock for the repair and inspection of vessels will be constructed. Both wooden and steel vessels will be built and there is plenty of good timber in the vicinity.

COMBINES OF GLASS FACTORIES IN SWEDEN.—An amalgamation has taken place of five of Sweden's more important window-glass manufactories, representing about two-thirds of the country's production of this kind of glass. The minimum capital is 3,000,000 kroner, maximum 9,000,000 kroner. There is stated to be no shortage of fuel or raw materials, at least for some time to come, whilst in Denmark, for instance, the glass industry has been most seriously inconvenienced.

HIGH PRICE FOR A GERMAN STEAMER.—A Rostock shipowner, the other day, sold the steamer *Minna Corde* at auction for 2,550,000 marks. She is 992 registered tons net, and has a carrying capacity of about 2,600 tons; the steamer was built at the Neptune yard in Rostock in the year 1908 and cost 490,000 marks. The boat was sold to a firm in Cologne. The *Minna Cords* earned no dividend during the first four years, 12 per cent. in 1912, 14 per cent. in 1913, no dividend in 1914, 5 per cent. in 1915, and 90 per cent. in 1916. Before the war her shares were offered at 50 per cent. their nominal value.

SCRAP METAL BALING PRESS.

CONSTRUCTED BY THE CANADIAN-AMERICAN MACHINERY COMPANY, LIMITED, ENGINEERS, LONDON.

(*For Description, see Page* 114.)

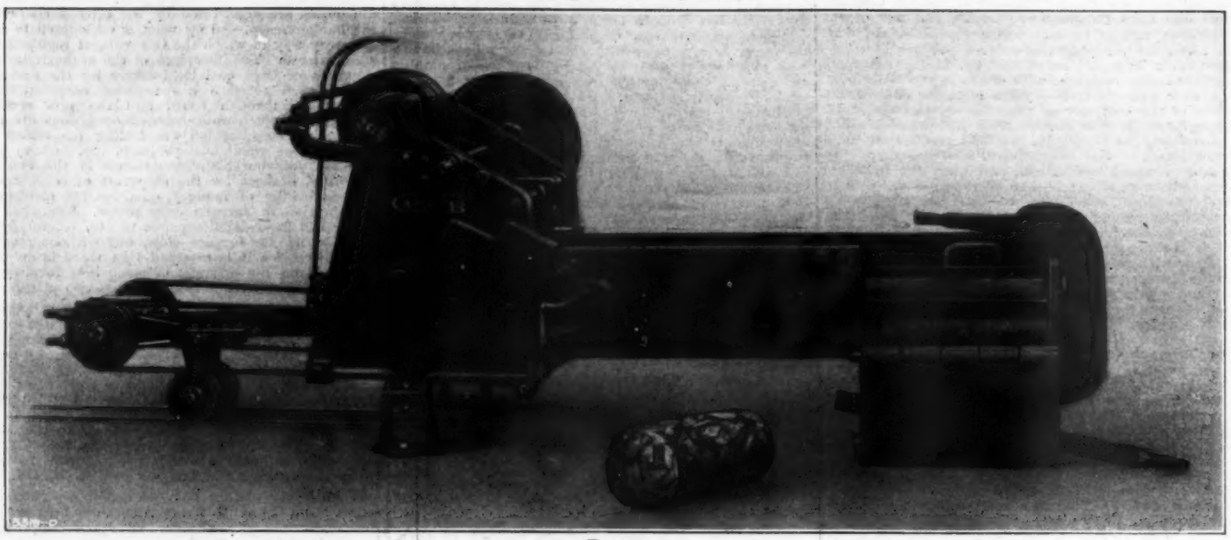


Fig. 5.

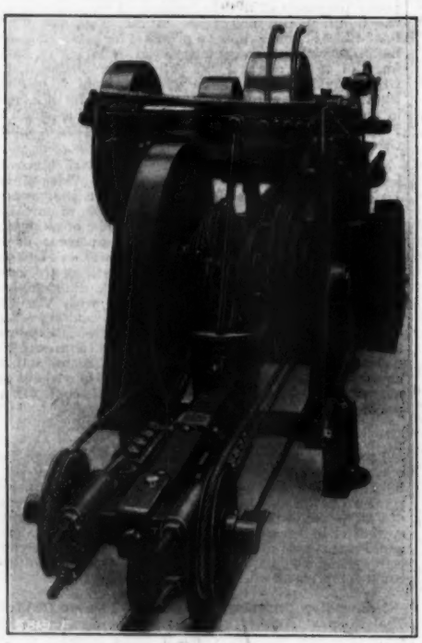


Fig. 6.

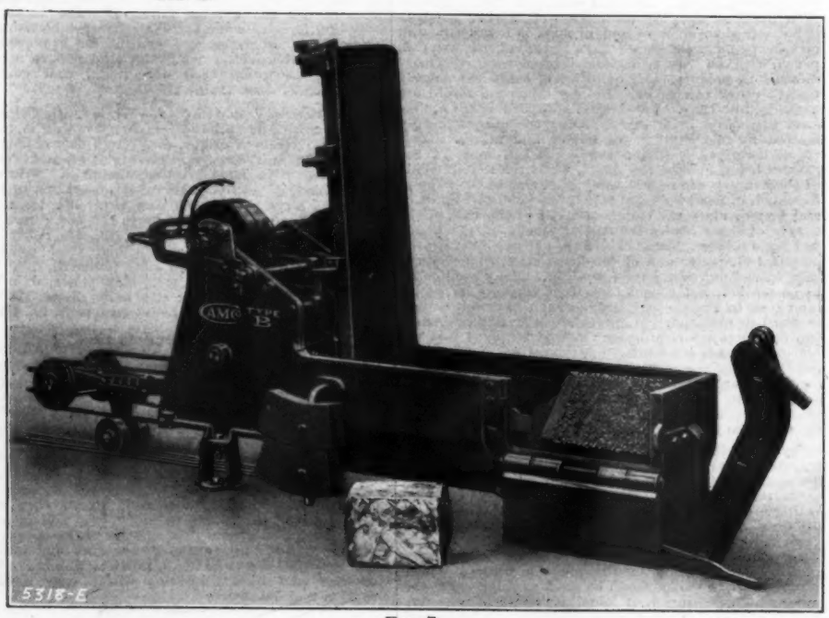


Fig. 7.

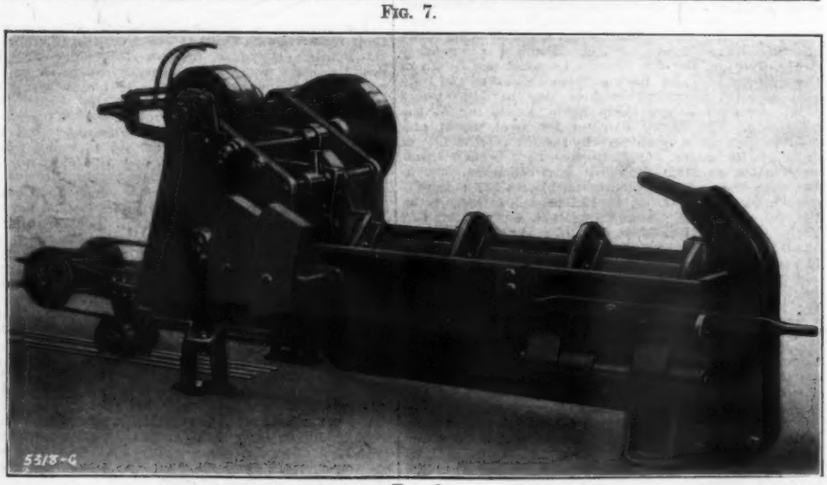


Fig. 8

The American Nitrogen Products Company.—This company, working on the Norwegian system, is showing much enterprise. Two factories are already in operation and large works are being constructed in the Cascade mountains, some 50 miles from Seattle. There one waterfall is calculated to have a capacity of 300,000 h.p. when fully exploited. The manufacture will in the first instance comprise nitrate of ammonia for explosives, and later on saltpetre. A railway is being constructed to Darrington.

Concrete Shipbuilding in Germany.—A 75-ton ferro-concrete motor cargo boat was launched on the Elbe on December 17, and for this vessel, it is said, a new kind of concrete has been used, consisting of four different constituents. It weighs only half as much as ordinary concrete. The material in question is said to have a specific gravity of 1.05 to 1.25. The new concrete in question is compact; it holds firmly to the reinforcement and is more elastic than ordinary concrete. In connection with this launch the various advantages claimed for ferro-concrete vessels have been further emphasised, and it is taken for granted that ferro-concrete vessels will have a great future for the Elbe traffic. As to the future of sea-going ferro-concrete vessels, opinions appear to be more guarded, but reports from other countries are admitted not to be unfavourable. Since Germany has a cement industry of considerable importance, future developments may be expected.

AGENTS FOR "ENGINEERING."

AUSTRALIA: Gordon and Gotch, Limited, Melbourne; Sydney; Brisbane; Perth. Turner and Henderson, Sydney, N.S.W. T. Willmett and Co., Townsville, North Queensland. W. C. Rigby, Adelaide, South Australia, Melville and Mullen, Melbourne, Victoria.
CANADA, Toronto, Ont.: Wm. Dawson and Sons, Manning Chambers. Montreal: Sells, Limited, 302, Shaughnessy Building, McGill-street.
EDINBURGH: John Menzies and Co., 12 Hanover-street.
FRANCE, Paris: Boyveau and Chevillet, 22, Rue de la Banque. For Subscriptions and Advertisements, Librarie B. Tignol, 53bis, Quai des Grands-Augustins, Paris. Also for Advertisements, Agence Havas, 8, Place de la Bourse.
GLASGOW: William Love.
INDIA, Calcutta: Thacker, Spink and Co. Bombay: Thacker and Co., Limited.
ITALY: U. Hoepli, Milan, and any post-office.
LIVERPOOL: Mrs. Taylor, Landing Stages.
MANCHESTER: John Heywood, 143, Deansgate.
NEW ZEALAND: Gordon and Gotch Proprietary, Limited, Wellington, Auckland and Christchurch.
NORWAY, Christiania: Cammermeyer's Boghandel, Carl Johans Gade, 41 and 43.
ROTTERDAM: H. A. Kramer and Son.
SOUTH AFRICA: Central News Agency, Limited, Head Office—Johannesburg; and Pretoria, Cape Town, Port Elizabeth, Bloemfontein, Durban, and their various branches and bookstalls throughout South Africa. Also Cape Town: Wm. Dawson and Sons, 31, Long-street.
TASMANIA: Gordon and Gotch Proprietary, Limited, Launceston: Hobart.
UNITED STATES: For Subscriptions, New York: W. H. Wiley, 432, Fourth Avenue. Chicago: H. V. Holmes, 957-965, Monadnock Block.
For Advertisements, J. S. Allan, 508, Stratford Avenue, Bridgeport, Conn., U.S.A.

ADVERTISEMENT RATES.

The charge for advertisements is three shillings for the first four lines or under, and eightpence for each additional line. The line averages seven words. Payment must accompany all orders for single advertisements, otherwise their insertion cannot be guaranteed. Terms for displayed advertisements on the wrapper and on the inside pages may be obtained on application. The pages are 12 in. deep and 9 in. wide, divisible into four columns of 2¼ in. in width. Serial advertisements will be inserted with all practicable regularity, but absolute regularity cannot be guaranteed.

Advertisements intended for insertion in the current week's issue must be delivered not later than 5 p.m. on Thursday. In consequence of the necessity for going to press early with a portion of the edition, alterations for standing advertisements should be received not later than 1 p.m. on Tuesday in each week.

SUBSCRIPTIONS, HOME AND FOREIGN.

REVISED RATES.

"ENGINEERING" may be ordered from any Newsagent in town or country and at railway book-stalls, or it can be supplied by the Publisher, post free, at the following rates, for twelve months, payable in advance:—

For the United Kingdom	£2 4 6
For Canada—	
Thin paper copies	£2 0 6
Thick " "	£2 5 0
For all other places abroad—	
Thin paper copies	£2 5 0
Thick " "	£2 9 6

When foreign subscriptions are sent by Post-Office Orders, advice should be sent to the Publisher.

All accounts are payable to "ENGINEERING," LIMITED. Cheques should be crossed "Union of London and Smith's Bank, Limited, Charing Cross Branch." Post-Office Orders should be made payable at Bedford-street, Strand, W.C. 2.

Offices for Publication and Advertisements, 35 and 36, Bedford-street, Strand, London, W.C. 2.

We desire to call the attention of our readers to the fact that the above is our SOLE ADDRESS, and that no connection exists between this Journal and any other publications bearing somewhat similar titles.

TELEGRAPHIC ADDRESS } "ENGINEERING," WESTRAND, LONDON.
TELEPHONE NUMBERS—8868 and 8568 GERRARD.

CONTENTS.

	PAGE
The Setting of Cement and Plasters	109
The Arrangement of Machine Shops.—No. XXIV (*Illus.*)	110
Scrap Metal Baling Press (*Illus.*)	114
The Engineering Pupilage and the Engineering Trade Apprenticeship	115
Traction on Bad Roads or Land (*Illus.*)	118
Committee on New Engineering Industries	120
Notes from the North	120
Notes from South Yorkshire	121
Notes from Cleveland and the Northern Counties	121
Notes from the South-West	121
Post-War Reconstruction Arrangements	123
The Motion of Electrons in Gases (*Illus.*)	124
The Financial Position of the German Iron and Coal Industries	125
The late Sir Alexander Meadows Rendel, K.C.I.E. (*With Portrait*)	126
Notes	126
Literature	128
Books Received	128
Industrial Notes	128
Submarine War (*Illus.*)	130
The Value of Superheating in Locomotives	130
Aircraft Construction	130
Recent Improvements in Balancing Apparatus (*Illus.*)	131
Krupp's Balance Sheet	132
Notes on Welding Systems	132
State and Municipal Electric Stations in Prussia	133
ENGINEERING Patent Record (*Illus.*)	134

With Four One-Page Plates of TRACTION ON BAD ROADS OR LAND.

NOTICES OF MEETINGS.

THE STAFFORDSHIRE IRON AND STEEL INSTITUTE.—Saturday, February 2, at 6.30 p.m., at the Institute, Wolverhampton Street, Dudley. A paper, on "Gas Furnaces as Re-Heaters of Iron Piles, &c.," will be read by Mr. G. Carrington, Vice-President of the Institute.

THE LONDON ASSOCIATION OF FOREMEN ENGINEERS.—Saturday, February 2, at 7 p.m., at Cannon Street Hotel, London, E.C. Discussion on "Scheme for the Encouragement of the Better Training of Lads in Engineering Workshops."

THE ROYAL SOCIETY OF ARTS.—Monday, February 4, at 4.30 p.m. Cantor Lecture.—"High-Temperature Processes and Products," by Mr. Charles H. Darling, A.R.C.Sc.I., F.I.C., Lecturer in Physics, City and Guilds Technical College, Finsbury. Lecture III: "Products and their Uses." Tuesday, February 5, at 4.30 p.m. Colonial Section.—"The Industrial Resources of South Africa," by Mr. C. du Plessis Chiappini, Trades Commissioner for the Union of South Africa. The Right Hon. Viscount Gladstone, G.C.B., G.C.M.G., G.B.E., will preside. Wednesday, February 6, at 4.30 p.m. Ordinary meeting.—"The Development of the Mineral Resources of the British Empire," by Mr. William Frecheville, A.R.S.M., F.G.S., M.Inst.M.M., Professor of Mining at the Royal School of Mines. Sir Dugald Clerk, K.B.E., D.Sc., F.R.S., Member of the Council of the Society, will preside.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, February 5, at 5.30 p.m. Paper to be submitted for discussion:—"The West Quay of Madras Harbour," by the Hon. Sir Francis Joseph Edward Spring, K.C.I.E., M.A.I., M.Inst.C.E., and Mr. Hugh Henry Gordon Mitchell, M.Inst.C.E.

THE RÖNTGEN SOCIETY.—Tuesday, February 5, at 8.15 p.m., at the Royal Society of Arts, 18, John Street, Adelphi, W.C. 2. Paper and demonstration by Mr. G. B. Batten, M.D., C.M., "A Simple Means of Obtaining 'Static Modalities' from an Induction Coil." Paper and demonstration by Mr. E. E. Burnside, "A Mobile Snook Apparatus."

THE LIVERPOOL ENGINEERING SOCIETY.—Wednesday, February 6, at 8 p.m., at the Royal Institution, Colquitt Street, when a paper will be read by Dr. F. J. Brislee, entitled "Annealing and Heat Treatment of Non-Ferrous Metals."

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Thursday, February 7, at 6 p.m., at the Institution of Civil Engineers, Great George Street, Westminster, S.W. The Ninth Kelvin Lecture:—"Kelvin as a Teacher," by Professor Magnus Maclean, D.Sc., F.R.S.E., Member.

NOTICE.

Owing to the recent Government restrictions, and to the enormous increase in the price of paper occasioned thereby, the Proprietors of "ENGINEERING" are compelled to advance the price of this Journal from 6d. to 8d. per copy. This increase dated from and included the issue of Friday, March 16. The change will not apply to unexpired subscriptions.

NOTICE TO NON-SUBSCRIBERS.

In view of the restrictions now imposed by the Government on the importation of paper, and of the consequent shortage of supplies, readers who wish to be sure of obtaining "ENGINEERING" each week should place an order for the Journal with a newsagent or bookstall clerk. Owing to the scarcity of paper it will be impossible in future fully to provide for a chance demand for this Journal.

ENGINEERING.

FRIDAY, FEBRUARY 1, 1918.

POST-WAR RECONSTRUCTION ARRANGEMENTS.

IT is gratifying to note that a complete system has been devised for the demobilisation of the army, and it is understood that the details are arranged to meet the requirements of industry rather than to suit military exigency. It is, further, pleasing to learn that employers in industry have already signified their desire for the return to their old positions of quite 60 per cent. of the men with the Colours. So that, if the arrangements of the military authorities are efficient, there should be a quick reinstatement of the fighting forces into the industrial army. This, of course, is not all that is necessary. There are one hundred and one questions to settle, principally regarding priority, and at the same time the difficulties of an adequate supply of machinery and material must be met. There are pivotal industries and pivotal men in each industry, and it is particularly important that the relative value to each industry of men and material to overcome inertia due to interruption of manufactures should be dealt with in a thoroughly organised way. When one remembers that prior to the war we were annually importing 50,000,000 tons, in considerable measure to maintain industry, and that there has necessarily been a very serious interruption to the import trade, due to the absorption of tonnage for war purposes, and that this interruption must necessarily continue for a considerable time after the war, it will be realised that extreme discrimination must be exercised in the supply of men and material to industries. Without attempting completely to differentiate the importance of industries, it will be conceded that shipping, transport (including railways) and the provision of machine tools and other producing appliances, must be specially considered. It were well if heed could be paid now to some of these requirements. For some time, even after peace is declared, exports must be controlled, to ensure that nothing is leaving the country which can effectively be utilised for the reconstruction of our industries.

The work done by the Ministry of Reconstruction, since its creation six months ago, is so far satisfactory, and, on paper, at all events, shows that all the requirements are being anticipated in a broad spirit. We can only hope that the machinery created will prove efficient, and that the levers will be manipulated with firmness of grip and decision to obviate interruption of movement and unsatisfactory lubrication. An Advisory Council has been organised representative of all the leading interests concerned in reconstruction, but, up to the moment of going to press, we have not learned the names of the members of this council. On these must largely depend the comprehensive character of the work, as well as vigour of action. The reconstruction may be said to embrace almost every department of the State, and this council must therefore concern itself with a great variety of public departments. In this duplication there is grave danger of inefficiency, and to be forewarned is to be forearmed. The main considerations should be the development of the maximum of effort by private enterprise, the minimum of Government control, with the maximum of Government support and stimulus. The council is to be divided into four main sections, one dealing with commerce and production; another with finance, shipping and common service; a third with labour and industrial organisations; and a fourth with social development, including agriculture, health and housing. All of these sections will have their sub-departments.

The section dealing with commerce and production is of primary importance, and already, in connection with the supply and control of raw materials, a committee of investigation has been set up with Sir Clarendon Hyde as chairman. The main line of action has already been referred to, but, as at present, it will be necessary immediately to provide raw material for such industries as may not be absolutely essential, but which may, nevertheless, become dormant, and involve extreme difficulty in their resuscitation. For the same reason financial assistance may be required, and, in connection with the support of British commerce and industry, a committee has been formed, with the concurrence of the Treasury, under the chairmanship of Sir Richard Vassar-Smith. The capital of many manufacturing firms has been almost exclusively absorbed in extensions required for war supplies, and consequently there will be very little working capital available after the war; nor will sufficient credit be easily secured. Then a first and vital requisite will be an adequate balance at the bankers. Sir Richard's committee will, we hope, make ample provision for this. Again, in many cases stocks of material have become depleted, and the cost of replenishing them will be great, owing to high prices. In some cases, especially where firms have changed over from peace manufacture to war work of an entirely different kind, the old stocks may still be existant. But whether this be so or not, there will be many cases of depleted stocks and a rising market, with a consequent need for financial assistance.

Another department has reference to the establishment of new industries, and a committee is already considering what can be done in this direction, so far as the engineering trade is concerned. The names of the members of the committee are given on another page. Already a preliminary list of possible products has been prepared, and we hope that this department of the work will have full scope. The labour problem connected with such new industries is to be the subject of consideration by a special sub-committee, as will also be the volume and nature of the demand for British goods after the war. An important consideration is the organisation of comprehensive trade associations for economising production. A

great change has come over official opinions regarding this matter, because it is realised that it is better in many cases to confine the individual factory to the manufacture and production of a specific type and size, leaving other factories to deal with variations of the same product of different design, finish and size. It is also realised that under such conditions economy in production can be best achieved, and the Government are therefore doing all they can to bring about such trade associations, the only proviso being that they shall have some object other than the fixing of price, which is often the aim of combines. A true application of the principle of trade organisation will cheapen production without affecting the earnings of the employees, and therefore facilitate the extension of British trade. In many of these operations the Ministry of Reconstruction has the co-operation not only of the Board of Trade and particularly of the Department of Overseas Trade, but also of the Ministry of Munitions, who are assisting in the collation of information from the controlled establishments. Consequently, in the opening of new markets the Department of Overseas Trade can be of immense advantage, and if they can get to work quickly and energetically they will be able to point the way along which we must go in establishing new industries, particularly for the absorption of woman labour after "the boys come home."

The Finance and Shipping Section will deal with the question of merchandise and exchange after the war, and to this section is to be relegated the very important duty of disposing of government surplus stores after the declaration of peace. It is impossible to estimate the value of these stores; they probably run into hundreds of millions sterling, and already the Department is compiling inventories of such stores for the service of the Committee. At the same time public bodies like county councils, road departments, and the Governments of the Dominions, are being consulted as to their possible requirements, so that there will be available, before the stores are liberated, some data on which to proceed in their disposal. In the words of the Department, the first object is "to protect the taxpayer from improvident selling; the second is to protect the markets, and therefore labour, from the dislocation which will inevitably result, if, for instance, some hundreds of thousands of motor vehicles were released for sale at once." The executive arrangements are being passed on to a specially created body, which will be composed of men of much experience in such work. The Advisory Council will lay down certain lines for their guidance.

The Labour Section of the Council must necessarily work in concert with the Ministry of Labour, and here there is danger of overlapping and unnecessary interference. The main item, however, so far as re-construction is concerned, is the establishment of industrial councils on the lines of the Whitley Report. In this connection it is to be stated, with regret, that very little progress has been made. So far in only one industry are industrial councils "in being." The difficulty, it is said, is the multiplicity and overlapping of employers' associations, and in some industries their entire absence, and we feel that so very much is to be gained by the organisation of these councils that we would urge, with as great a conviction as possible, action by employers' associations towards co-operation with the Ministry of Reconstruction. These industrial councils are to be commended because their existence will minimise, if it does not entirely avoid, direct government control over the details of industry. This is an aim worthy of great effort and of some sacrifice in regard to the seniority or prior claims of conflicting employers' associations. This section, too, is dealing with the question of labour in merchant shipping, the war time departures from trade union practices, industrial courts, industrial structures and apprenticeship. It will, moreover, be concerned with the question of demobilisation and the absorption of service labour after the war for the prosecution of public works and the rectification of the relation between men and women workers. As to the section dealing with social arrangements little need here be said, but the question of housing arrangements, now far advanced, concerns the simplification of building by-laws, as well as of material for the construction of houses. A great saving can be effected, too, in lawyers' fees in connection with land transfer, but we need not enter into further details, because what we have said shows that the aim of the Department of Reconstruction is sufficiently comprehensive, and it is to be hoped that their policy in prosecuting this aim will be dictated by the desire to advance national rather than sectional interests.

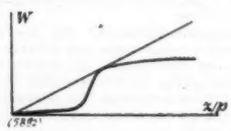
THE MOTION OF ELECTRONS IN GASES.

Last Friday's discourse at the Royal Institution was given by Professor J. S. Townsend, F.R.S., of Oxford, on "The Motion of Electrons in Gases." The subject has been the lecturer's special study and may perhaps be introduced by a few words, as there is considerable diversity of opinion upon the questions at issue. An ion is something, an atom, molecule, or group of molecules, which, in gases and liquids, carries one or more charges of electricity. In gases at ordinary pressure the ions are supposed to be the carriers of the current, in highly rarefied gases the free electrons themselves are regarded as the carriers. The number of molecules to which an ion is attached may be large (up to 30) or small; some scientists speak of an "average mass" of the ion. As the gas pressure is reduced, the number of molecules in an ionic group or cluster is said to diminish; thus if we could follow an ion through a gas being rarefied, its mass would become smaller and smaller, and an average mass might be ascribed to the ion. The mass of the ion might also be influenced by other factors, impurity of the gas, especially water vapour, and the electric and magnetic forces. The mobility or velocity of the ion varies greatly; it will depend upon the mass and field intensities, the rate of recombination, and as in all movements of small particles, on kinetic factors, temperature, mean free path, number of collisions, interdiffusion of the ions and molecules, &c.

The velocity of the ions, Professor Townsend said in opening his lecture, was first directly determined by J. Zeleny, twenty years ago. Zeleny took two long concentric tubes of metal, charged to a potential difference; a beam of Röntgen rays was passed across the outer tube, at right angles to it, ionising the air in it; an air current was sent along the inner tube and along the annular space between the tubes, while ionised air moved through the annular space. The electric field accelerated or retarded the ions with regard to the air current (according to their positive or negative charge), on their way to an insulated portion of the inner tube, joined to an electrometer. The velocity measurements thus made gave for positive (negative) ions the following values W in centimetres per second: In air, 1.36 (1.87); hydrogen, 6.7 (7.97); carbon dioxide, 0.76 (0.81), all under an electric force of 1 volt per centimetre and in gas at 1 atmosphere. Zeleny thus found a slight difference in the velocities of the positive and the negative ions; he made many more measurements, and his values were on the whole confirmed by Langevin and others.

These results, Professor Townsend continued, were affected by the velocity of agitation of the ions and their rate of diffusion into the molecules surrounding them. Owing to the kinetic agitation, gas particles, crowded together at one spot at a given moment, would form a more open cluster the next moment, and their ordinary movements were in all directions. Hence some of the ions travelling with the air would strike the wall of the tube, and be discharged on it, and not all the ions produced would actually get through a narrow long tube. The calculation of these conditions was very complicated. To investigate them, he had made use of a wide tube, in which a number of narrow tubes, 1 mm. bore, were arranged axially in a ring as in a locomotive boiler; the ions travelled down the fine tubes and were discharged on a central electrode. In order to find how many ions got through he had first to determine, how many went into the fine tubes; this he had ascertained with the aid of a similar apparatus in which the fine tubes were very short in length (ports). It resulted that about half the number of ions entering got through tubes, 4 cm. long, under a force of 80 volts per centimetre; further, that the coefficients of diffusion of ions into dry gases at atmospheric pressure were, again for positive (and negative) ions, and in cm. per second: Air, 0.028 (0.043); carbon dioxide 0.023 (0.026); hydrogen, 0.123 (0.190). The corresponding rates of diffusion of ordinary gases were: CO_2 into oxygen, 0.14; CO_2 into hydrogen, 0.555; oxygen into CO_2, 0.18, into hydrogen, 0.72. Thus the coefficients of diffusion of ions into gases were smaller than those of one gas into another; if the diffusion depended upon the diameter of the particles, the positive (negative) ion in dry air would have about three (two) times the diameter of the air molecule (Langevin). From these considerations, and the known values of the number of molecules N per cub. cm. of any gas, $N=2.7\times10^{19}$, of the charge $e = 4.5 \times 10^{-10}$ electrostatic unit, the product Ne could be deduced; the calculation yielded for positive (negative) ions: In air, 1.45 (1.31); hydrogen, 1.63 (1.25); carbon dioxide, 0.99 (0.93), all with the factor 10^{10}, whilst for electrolytes the same product Ne had, in oxygen, hydrogen, carbon dioxide, the values 1.23, 1,24, 1.23, again in each case with the factor 10^{10}. That in gaseous ions the positive value was a little larger than the negative was probably due to the fact that some positive ions carried two charges, and not only one charge e.

In mobility experiments it was found that the velocity of the ions W in the direction of the force increased with that force Z (in volts) and increased also when the gas pressure p (in millimetres of mercury) was reduced; at high evacuation the latter effect predominated. When the W (in centi-



metres per second) were plotted against the quotient Z/p, it was found that the velocity of the positive ions followed a straight-line law for moderately large Z/p, to grow more rapidly afterwards; in the case of the negative ions there was, with low pressures, a sudden very strong rise in the curve at $Z/p = 0.5$ already, as if the electrons were moving freely, unimpeded by molecules. Thus in dry air at 29 mm. pressure the negative ions had a velocity of 926 cm. for $Z = 2.3$ volts, whereas, if the ion travelled with the mass which it had at 760 mm. pressure, the velocity would be 114 cm.; the mass associated with the electron seemed hence to be smaller than the mass of a molecule. Further to investigate these relations, the apparatus was arranged as follows (similar apparatus had served for the determination of the Ne in one experiment, and not for many experiments during which the conditions could not be kept rigorously constant, the quantity measured being the ratio of the velocity to the rate of diffusion):—A stream of ions passed through a gauze and through a hole in a metal plate underneath it into a uniform electric field; opposite the hole or slot was either a disc electrode n_2 surrounded by a flat ring (a guard ring), or a disc electrode divided by two strips of insulation into three parts; the stream would directly strike the central disc n_2, but if opened out by diffusion and agitation in calyx fashion, the particles would also fall on the guard ring or on the two lateral plates n_1, and n_3; the total charges and the ratios of the charges on n_2 and on $(n_1 + n_3)$ were determined. By means of a revolving commutator and a split battery the field was further reversed, so that the ions, on their way to the lower electrodes n, would under certain conditions be driven back and travel up and down in zigzag without touching the n. Electromagnetic deflection was also resorted to for the measurements of very fast ions. It resulted that, in most carefully dri d air at low pressure, the stream of ions would open out very much (abnormal diffusion); but a little water vapour of a partial pressure of 0.1 mm. would be sufficient to suppress this abnormal diffusion, at least with small electric forces. When the electric force was strong, the effect of the water

vapour vanished and the electrons seemed to be moving freely with a kinetic energy of agitation far exceeding that of the surrounding molecules of air. One might consider that an electron, hitting a gas molecule, would under ordinary conditions bound back in any direction. An electric field would influence that direction of movement in the short interval between consecutive collisions; the negative ions would not lose their energy after collisions, but would move with increased energy, because the intervals between collisions would be shortened, and the ions would then acquire a considerable excess energy of agitation. The experiments at different Z and p proved that the increase in the velocity of agitation set in suddenly; this was explained by curves and tables. With increasing Z/p the velocity W of the negative ion in the direction of the force first increased slowly; then followed a rapid increase, as the electron detached itself from the eight or ten molecules with which it was associated; afterwards there was little increase (see diagram on previous page). Professor Townsend explained how the calculations could approximately be conducted after the manner of calculations of falling bodies, his data including the velocity of agitation, and the mean free path; the mean free path of a molecule of air at 1 mm. pressure is $7.5 \times 10^{-6} \times 760$ cm. He also indicated how the ratio e/m could be deduced from the determinations of the velocity of agitation and the velocity under electric force. The resulting values of e/m for $Z/p = 0.2, 0.5, 2, 10, 100$ were 5.1, 5.8, 5.4, 3.9, 3.8×10^{17}. The accepted value for e/m is 5.3×10^{17}, so that, for $Z/p = 0.2$, the negative ion would, from this consideration as well, appear to be in the electronic state.

THE FINANCIAL POSITION OF THE GERMAN IRON AND COAL INDUSTRIES.

THE Kaiser has never hesitated to act as commercial traveller when he has seen an opportunity of advancing the industrial interests of his country, and it is also believed that he has shown much enterprise and shrewdness in the management of his private affairs. He has admitted the great captains of industry to much personal intimacy and has encouraged them to launch out in every direction which offered an opportunity of securing for Germany the world position which he sought for her. He has surrounded himself with a band of very capable men, adroit in finance and expert in manufacture, and has put the services of the vast bureaucracy of the country at their disposition in their attempt to obtain control of the sources of raw material abroad, and to capture foreign markets in both hemispheres. This plan, admirably as it has worked in the past, presupposes that there shall be no check to German success. Great and powerful interests yield a ready obedience as long as they are allowed to reap large profits and their schemes attain a satisfactory measure of success. But if affairs go badly, and they are asked to make sacrifices they are apt to assume the position of a Frankenstein and to cause much misgiving to their author. In such a case they may appear so menacing that even the courage of an all-highest may recoil from provoking a conflict with them. It is only on some such ground that we can explain the continued high profits of the heavy industries of Germany—the iron and steel works, and the coal and iron mines. These industries are almost entirely occupied in the production of munitions for the military, and, of course, like all other manufacturers in war time, they are under the control of the Government. But each year they pay larger dividends, put more to reserve, and distribute greater sums among the benevolent institutions attached to their works. The smaller and less potent industries of Germany look on with envious eyes at fortunes gathered out of the loans contributed by all classes of society.

In illustration of this remarkable prosperity of the heavy industries we have compiled a number of tables giving particulars of the capital and profits of the chief firms. From these it will be seen that as regards the last financial year all the iron and steel firms were employed to the utmost of their capacity, principally, of course on account of the requirements of the army and navy, but also to some extent for peace purposes. The production has been pushed to the utmost, and there is no likelihood of a reaction at present, since the war approaches its greatest intensity. Although figures representing the production are not available, it almost goes without saying that the very tangible increase in profits has been attended by, or rather results from, a marked increase in the output, in spite of a certain shortage of skilled labour and temporary transport difficulties. Last year has left the previous, likewise very favourable, year a fair distance behind, nor have any other German industries in all probability done as well as those with which this article deals, although the chemical industry, for instance, has also reaped a great harvest. Of the concerns with regard to which particulars are here given, all save two have earned record profits, and distributed dividends which are equal to, and in many cases materially greater than, the best peace figures. As far as last year is concerned only one firm, but that certainly the leading firm of all, viz., Krupp, has found it expedient to reduce its dividend by 2 per cent., compared with the previous year, but there was no evident necessity for such reduction. The reduction in dividend by the Westphalian Steel Works, Bochum, was only apparent, the high dividend for the previous year representing the payment of some arrear dividends on preference shares.

The coal mining concerns do not show great increase in profits which can vie with those of the iron and steel works, and the so-called mixed works which own both mines and ironworks. Still the former show aggregate increases in writings-off amounting to 8,300,000 marks, and increased aggregate net profits of 9,536,000 marks, which enabled the undertakings in question to raise the average of the dividend from 12.2 per cent. for the previous year and 12.8 per cent. for the last peace year to 14.4 per cent. The reserves were also increased by about 1,000,000 marks. The Köln-Neuessen Mining Company, with a nearly doubled net profit, was able to declare a dividend of 40 per cent., equal to the last peace dividend, against 35 per cent. for the previous year. Also the Hibernia concern, the much discussed State undertaking, shows a material increase and was able to declare the peace dividend of 15 per cent. Among the mixed works good results have been achieved both in the Rhenish-Westphalian, the South-West German and the Upper Silesian districts; the average profits of the South-West German works

THE CAPITAL AND PROFITS OF GERMAN IRON, STEEL AND COAL COMPANIES.

	Share capital (Marks).	Writings-off and reserves prior to net profits. (1,000 Marks).				Net profits. (1,000 Marks).				Dividends.			
		1913 or 1913–14.	1914 or 1914–15.	1915 or 1915–16.	1916 or 1916–17.	1913 or 1913–14.	1914 or 1914–15.	1915 or 1915–16.	1916 or 1916–17.	1913 or 1913–14.	1914 or 1914–15.	1915 or 1915–16.	1916 or 1916–17.
I. MIXED WORKS.													
(a) *Rhenish-Westphalian.*										per cent.	per cent.	per cent.	per cent.
Krupp	250,000,000	21,109	37,980	85,143	83,426	63,904	86,466	49,657	40,976	12	12	12	10
Gelsenkirchen	188,000,000	24,804	16,651	22,728	22,024	24,141	12,433	16,905	27,979	11	6	8	12
Phönix	105,000,000	12,353	12,507	12,756	12,442	23,229	15,070	32,848	43,291	10	12	20	20
Rhenish Steel Works	60,000,000	5,121	4,023	7,211	9,000	4,894	2,805	5,086	7,089	10	6	10	12½
Bochum Union	36,000,000	2,944	4,436	7,289	7,329	4,360	7,418	15,335	15,558	10	14	25	25
Gutehoffnung Hütte	40,000,000	7,522	7,077	10,214	9,530	6,992	2,395	23,408	18,478	10	15	20	20
Buderus Company	22,000,000	2,223	2,139	2,376	2,635	1,978	—	1,917	3,019	7	0	5	7½
Hoesch Company	28,000,000	4,252	4,374	4,760	10,243	604	1,086	8,841	17,344	15	12	20	24
Georg Marie Company	18,500,000	2,481	2,442	4,549	10,285	1,559	1,553	2,282	2,006	Ord. 0 Pref. 6	0 6	3 6	10
(b) *South-Western Germany.*													
German Luxemburg	130,000,000	16,000	16,500	22,900	25,000	8,388	loss 7,870	9,739	24,929	—	—	7	10
Aumetz-Friede	58,000,000	5,017	5,023	6,580	12,436	6,798	999	7,516	7,986	6	—	10	10
Rombach Co.	50,000,000	3,967	4,408	4,475	6,711	7,157	2,652	4,775	8,352	5	5	8	12½
Röchling	20,000,000	3,080	2,790	4,920	7,890	—	—	—	—	5	5	5	7½
(c) *Upper Silesian.*													
Oberbedarf Company	48,000,000	3,608	3,604	6,009	9,429	2,410	1,500	6,135	9,995	4	2	10	15
Laura Hütte	36,000,000	6,520	6,262	6,075	2,143	3,392	2,442	5,297	9,876	4	4	10	12
Kattowitz Company	39,000,000	2,000	2,500	2,500	2,500	5,264	3,708	6,868	6,499	13	8	12	12
Upper Silesian Iron Works	28,000,000	2,000	2,000	3,000	4,000	571	239	1,993	3,312	—	8	6	10
Donnersmarck	15,000,000	3,200	2,470	3,099	2,700	3,347	1,981	3,707	36,03	24	12	18	18
II. COAL MINING CONCERNS.													
Harpen	85,000,000	9,998	9,103	10,681	10,661	9,239	5,607	11,187	11,187	8	6	12	12
Hibernia	70,000,000	5,011	4,102	4,281	5,039	10,624	5,316	7,421	10,021	15 4½	8 4½	11 4½	15 4½
Eschweiler	38,000,000	3,500	2,578	3,500	4,000	4,334	4,230	4,221	5,066	10	10	10	12
Essen Coal Mining Company	25,000,000	2,117	2,000	2,729	2,483	2,650	2,109	2,809	4,027	10	10	10	10
Consolidation Company	20,000,000	1,887	1,486	1,333	3,425	4,841	3,301	3,931	4,648	23	15	18	22
Mülheim Mining Company	14,000,000	814	795	802	968	1,701	1,083	1,560	1,635	11	7½	10	11
Königsborn Company	11,000,000	1,750	1,000	1,000	1,500	3,002	1,346	1,667	2,313	18	10	10	15
Köln-Neuessen Company	10,500,000	2,805	2,205	3,447	3,000	4,829	3,567	3,458	6,879	40	25	35	40
III. IRON AND STEEL WORKS.													
Mannesmann Company	72,000,000	6,682	2,939	7,358	18,625	5,641	8,120	16,987	24,749	7½	10	15	18
Bismarck Hütte	16,000,000	2,280	4,497	4,870	11,589	1,633	3,580	5,354	5,412	9	15	25	30
van der Zypen Company	17,000,000	1,444	1,707	10,364	10,433	2,150	3,413	6,954	6,961	8	12	25	25
Westphalian Steel Works	12,500,000	1,188	1,910	3,287	3,546	loss 37	121	1,611	1,471	—	—	20	8
Hasper Iron Works	13,000,000	1,305	1,202	2,944	4,502	1,331	236	3,604	5,616	5	4	16	16
Facon Mannst Company	10,000,000	1,099	1,288	3,050	4,950	647	109	1,125	1,253	5½–6	0–6	8–8	9
Friedrichs Hütte	4,000,000	420	372	1,582	3,800	400	352	2,684	1,225	5	8	20	25
Kraft Iron Works	22,500,000	2,600	1,697	1,905	2,569	2,666	2,372	2,900	3,519	12	6	10	12
Ilseder Hütte	15,000,000	2,290	1,930	2,280	1,900	4,320	3,865	5,366	5,970	25	24	33½	36
Maximilians Hütte	23,440,000	4,297	3,184	4,340	7,527	3,407	2,740	3,723	4,143	10½	12	12	12
Lauchhammer	10,000,000	1,585	1,893	2,865	5,846	1,220	1,863	4,015	6,189	6	10	15	20

cannot compare with those of the other two districts. This is partly due to the fact that at the South-Western works the available ore is mostly of a somewhat inferior quality, and also to their less favourable location during the war. The most striking results have been achieved by the iron and steel works, which after very substantial writings-off and large sums having been reserved, have increased the aggregates of their net profits by 60,000,000 marks and the average of their dividend by a further 2 per cent.

The figures of writings-off and net profits represent 1,000 marks. In several instances, especially as regards the mixed Rhenish-Westphalian works, the capital has been increased within the four years referred to above.

The aggregate capital of the different of the above classes of work amounts to :—

	Marks.
I. (*a*)	748,500,000
(*b*)	258,000,000
(*c*)	166,140,000
II.	273,500,000
III.	215,440,000
	1,661,580,000

The aggregate writings-off and reserves deducted prior to the net profits amount in the aggregate for the four years, respectively to :—

	Marks.
1913 or 1913–14	181,370,000
1914 or 1914–15	182,674,000
1915 or 1915–16	288,788,000
1916 or 1916–17	349,000,000

whilst the sum reserved out of the net profits, including the sums carried forward for the four respective years in the aggregate amount to :—

	Marks.
1913 or 1913–14	56,111,000
1914 or 1914–15	74,252,000
1915 or 1915–16	79,368,000
1916 or 1916–17	101,853,000

The aggregate net profits were :—

	Marks.
1913 or 1913–14	203,586,000
1914 or 1914–15	191,589,000
1915 or 1915–16	292,582,000
1916 or 1916–17	353,474,000

The average dividend for all the concerns dealt with above for the four years was respectively :—

	Per cent.
1913 or 1913–14	8.2
1914 or 1914–15	7.3
1915 or 1915–16	11.9
1916 or 1916–17	13.9

and the amounts paid out in dividends and bonuses reached an aggregate of respectively :—

	Marks.
1913 or 1913–14	136,885,000
1914 or 1914–15	121,204,000
1915 or 1915–16	197,855,000
1916 or 1916–17	229,258,000

The war has influenced the different branches and districts very differently ; thus during the four years the average dividend for section I*a* only rose from 10.7 per cent. to 13.7 per cent., whilst the average dividend for I*b* section rose from 2.7 per cent. to 10.3 per cent. and for section I*c* from 6.7 per cent. to 13.1 per cent. Within the coal mining industry the rise was less pronounced, viz., only from 12.8 per cent. to 14.4 per cent., whilst for the iron and steel works under section III the average dividend rose from 7.7 per cent. to 18.6 per cent.

NOTE.

Army Service and Protected Occupations.

The Ministry of National Service has published a set of printed notices dealing with the changes in the Schedule of Protected Occupations, under which certain men are to be recruited for the Army from protected trades. The Schedule in question—of which an amended edition (M.M. 130, revised) comes into force to-day—was first introduced in May, 1917, to replace the systems of badges and trade cards. The trades in the Schedule M.M. 130, revised, are divided into sections, dealing with shipbuilding and repairing; mining and quarrying other than coal-mining; furnace fire-bricks; coke-oven plant; metal manufacture (not foundry); engineering including foundry workers; railway wagon construction and repair; aircraft construction and repair; instrument making; miscellaneous metal trades; &c. The age limit is given in each occupation, the age being reckoned as it was on January 1, 1917, which date has been taken in the revised edition since it was the date adopted in the old schedule. The revised schedule is accompanied by an index of the occupations dealt with. From this we see, as an example, that for an analytical or research chemist (works), Section R.—Professional occupations, Administrative and Technical Staff, Code No. 2001, the age limit is 23, on January 1, 1917. By reference to the notes applicable in this case we find that "if a man is medically classified as fit for general military service (Grade 1), he is protected by the schedule only if he satisfies all the following conditions: . . . (*d*) If he entered the scheduled occupation (not necessarily with the same employer), on or before August 15, 1915; or (*e*) alternatively to (*d*), if the occupation is marked (*a*) in the schedule, if he entered the occupation (not necessarily with the same employer) before January 1, 1918." Under (*a*) the schedule says: "The man is protected if he is engaged on Admiralty, War Office or Munitions work, or in a railway workshop, or alternatively, if not so engaged, is enrolled as a War Munitions Volunteer." Another instance is that of a draughtsman (not a tracer), on engineering, structural steel or reinforced concrete work. Section F.—Engineering, &c. Code No. 0618; the age limit is also 23, on January 1, 1917. The reference which applies to the draughtsman in question, under the mark (*s*) says that "in the case of any man employed in an occupation marked (*s*) in the schedule, the Admiralty, War Office or Ministry of Munitions, as the case may be, may require that a substitute is provided who, in their opinion, is satisfactory before the man is released for military service." The men to be withdrawn are those which come under the three following categories: A. Men under 24 years of age who are fit for general service (Grade 1), with the exception of a few classes of men engaged on ship construction and repair. B. Men fit for general service up to a higher age than 24 engaged on certain kinds of work which can be done after a short period of training by men above military age, or otherwise unfit for military service, discharged soldiers, or women. C. Men fit for general service who have entered war industries since August 15, 1915, except in certain departments of aircraft production and a few small industries which have been set up since 1915. A National Service Medical Board composed of civilian doctors is to decide whether a man is medically classed in Grade I. With the help of the document now issued there should be no difficulty in ascertaining whether any man is liable or not to be taken for service in the Army.

Association of Teachers in Technical Institutions (London Branch).—A meeting has been arranged by the Association of Teachers in Technical Institutions to be held at the Polytechnic, Regent-street, W., on Saturday, February 2, 1918, at 3 p.m., to discuss the question of remuneration. All teachers in technical institutions, junior technical schools and trade schools (whether members of the association or not) are invited to attend.

National Union of Manufacturers.—The Midland Council of this body has arranged for a second lecture of a series on "After the War Problems," to be given by Sir Herbert Austin, K.B.E., on Monday, February 4, at 2.30 p.m. in the Assembly Room of the Birmingham Chamber of Commerce. The subject will be "A Few Remarks on Works Costs," and Mr. F. Dudley Docker, C.B., will be in the chair. Tickets can be obtained from Mr. George Pike, c/o Messrs. John Yates and Co., Aston Manor, Birmingham.

The late Mr. William Sloane Accles.—We regret to have to announce the death, which occurred at his residence, Hazel Lodge, 26, Holland Villas-road, Kensington, W., on Saturday, January 26, of Mr. William Sloane Accles. Mr. Accles was 61 years of age, and at the time of his death had been for 21 years in charge of the London Office, 25, Victoria-street, S.W., of the Niles-Bement-Pond and Pratt and Whitney Companies. Mr. Accles was an American citizen, and came from Hartford, Conn. He served his apprenticeship at Colt's Armoury, and worked as a young man in the shops of the Pratt and Whitney Company. He was a director of the American Chamber of Commerce in London, a Fellow of the Royal Geographical Society, and a member of the Institute of Mechanical Engineers. His loss will be keenly felt by his staff and by a wide circle of friends.

THE LATE SIR ALEXANDER MEADOWS RENDEL, K.C.I.E.

With the death of Sir Alexander Meadows Rendel, K.C.I.E., at his residence in London, on the 23rd inst., there has closed a long life of nearly eighty-nine years, full of honest and effective work having immense influence on the development and prosperity of our great Indian dependency. It is recognised that the commercial success of a country is largely dependent on its lines of communication for the distribution and transit to shipboard of its natural products, a condition which applied with particular force to India. Sir Alexander Rendel's first visit to India was made in 1857, immediately after the mutiny, and from this time forward he worked with energy for the extension of the railway system of that Empire. At the date named there were only 500 miles of railway; to-day there are 36,000 miles. Beginning as consulting engineer to the East Indian Railway in 1857, he became in 1872 consulting engineer to the Secretary of State for India. From this time onward he was responsible for the building up of the great State railway system of our dependency. He accepted also corresponding appointments to other Indian railway companies. Thus he was responsible for the building of thousands of miles of railway, and for many years has been consultant in connection with nearly three-fourths of the entire railway mileage of India. He has bridged most of the great rivers of India, varying in width from 1,000 ft. to 10,000 ft. In connection with rolling stock, it is worth mention that he has seen and largely directed the development of locomotives from the express engine the "Fairy Queen," the largest broad gauge engine of the 'fifties, weighing about 18 tons, up to the 120 tons engines of to-day; while on the State metre-gauge railways he has been responsible for the development from the 16.4-ton locomotive of 1873 to the 71-ton engine of to-day. These brief suggestions of his work will disclose, upon careful reflection, to the student of the internal economy of countries, some measure of the immense influence which Sir Alexander has had upon the evolution of the present-day prosperity of the Indian Empire.

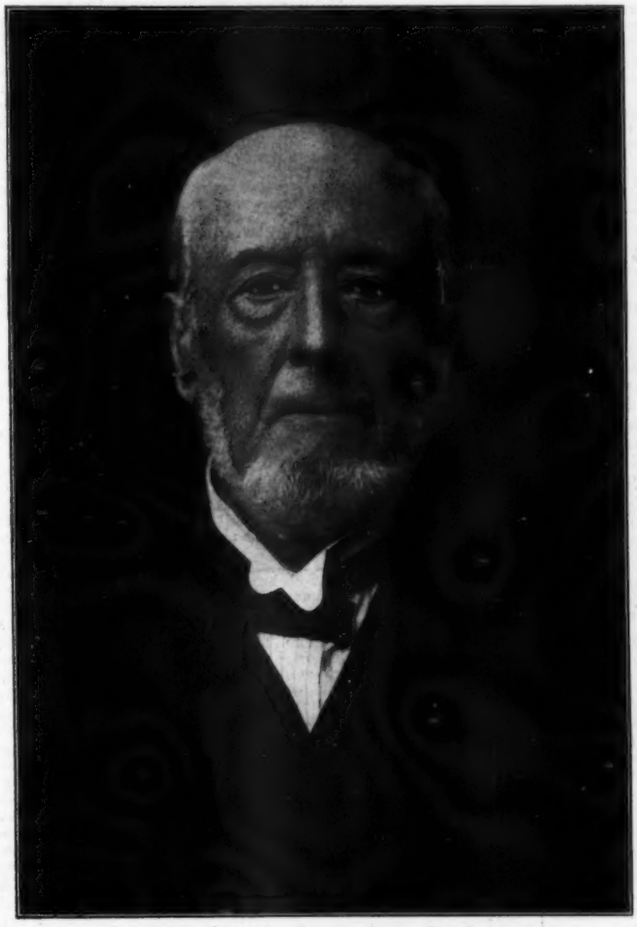
In his work he brought to bear a thoroughly disciplined mind, accepting little without demonstrated proof. He was firm in his decisions, equally tenacious in his beliefs, and while receptive of suggestion, demanded before he changed his attitude, full evidence of the advantages to be expected therefrom. In his specifications for work to be done, he was precise, laying great stress on adequate tests alike of the material and of the finished product, and as a consequence the work done under his direction invariably proved reliable. Ready to concede recognition for good work, he was unsparing in his condemnation of careless, and still more of thoughtless, departures from the right path. In his bridge design he aimed at thorough investigation of stresses and his contract plans were fully detailed to obviate the necessity of further drawings being required at a later date by the manufacturers. At the outset of his career he made an important departure in connection with foundations. The river beds of India are for the most part of sand and silt, and the practice in preparing foundations, which had been passed down from the primitive age of well sinking, was to have a great number of timber well-curbs of small diameter, with iron cutting edges, and later well-curbs of iron or steel. These were sunk by open dredging. Sir Alexander, however, changed this, reducing the number in the first case which came under his consideration from twelve wells 10 ft. in diameter to three of 18 ft. in diameter. Another trait in his character which greatly influenced his success in administration was his judgment of character. Thousands of appointments to the different railways in India have from first to last been made upon his recommendation, and in the great majority of cases complete success was the result. In this he was helped by a wonderfully retentive memory which enabled him to recall the career of most of his protégés. These, however, are the characteristics of the well trained engineer, and to this category Sir Alexander certainly belonged.

Heredity, too, had a part in the development of

his talents. Born on April 3, 1829, he was the eldest son of one of the pioneers of modern civil engineering and one of the early presidents of the Institution of Civil Engineers, Mr. James Meadows Rendel, F.R.S.; and his three brothers, who predeceased him, Lord Rendel, George Rendel and Hamilton Rendel, were partners with Sir William (afterwards Lord) Armstrong, and had a great part in the building up of the Elswick firm. His early education was at King's College, Canterbury, and later at Trinity College, Cambridge, where he took a scholarship and passed high in the wranglers' list. His introduction to the engineering career was with his father, and on the death of the latter in 1856, he became head of the business, proceeding, as we have already said, in the following year to India when he was appointed consulting engineer to the East Indian Railway.

Before referring in detail to the important works carried out in India, reference may be made to the undertakings in this country for which he was engineer, and in the carrying out of which he divided his attention for many years with his Indian projects. He was appointed engineer to the London Dock Company in 1856, and amongst the works carried out in the Port of London were the Hermitage Wharf and the Shadwell Basin. But one of the most important of his metropolitan schemes was the construction of the extension of the Victoria Dock, now the Royal Albert Dock. This work, commenced in 1875, was the largest enclosed dock in the world, having an area of over 80 acres, and included two dry docks and a tunnel or covered way to carry the Great Eastern Railway Company's North Woolwich branch under the junction channel between the Victoria and the Albert Docks as well as certain swing bridges and railways for public and dock traffic. He was responsible also for the Edinburgh and Albert Docks at Leith, and continued for many years consulting engineer to the Leith Harbour and Dock Commissioners. Smaller docks to his design were built at Workington, Llanelly and Kirkcaldy, while he also completed docks at Milford. He was also interested in works at Wicklow Harbour. When the Uganda Railway was started he was chosen by the Government to act as consulting engineer, and he served in a similar capacity for the Egyptian Delta Light Railways and for the Mexican Railway Company.

It was, however, in India that his principal work was done, and up to the end of his life he continued to be interested in our Eastern dependency. Many miles of bridges have been built by him, some of them of great length. The longest of these is the Upper Sone Bridge, on the East Indian Railway, which has a length of 10,052 ft., or nearly 2 miles. The next in point of length was the Alexandra Bridge, over the Chenab, which, as originally built consisted of 133 spans, having a total length of 9,088 ft., but in later years this was reduced by the adoption of banks at either end and a reduction of the width of the channel. At present the second longest bridge in India is the Godavari, which consists of 56 spans of 150 ft., and totalling 9,096 ft. But judged by importance the Lansdowne Bridge over the Indus at Sukkar and the Hardinge Bridge over the Ganges at Sara Ghat take precedence of any of those named. The first, opened in 1889, is notable because, when completed, it had a cantilever span of unexampled length, being 820 ft. in the clear; but the Forth Bridge, which was then in course of construction, soon eclipsed this record. Another notable cantilever bridge is that at Khusalgarh, over the Indus, consisting of an anchor span of 303 ft. and a cantilever of 471 ft. The Hardinge Bridge is notable because it is unexcelled among the Indian bridges for the weight of steel required, and it is probably the most important bridge structure in India. It is built for double track, has 15 spans of nearly 350 ft. in length, with three land spans at each end, the total length being 5,893 ft. The cylinders for the piers, sunk by dredging, had in some cases to be sunk to a depth of 180 ft. Without attempting to exhaust the list—since this would occupy too much space—we may refer to the Empress Bridge over the Sutlej, opened in 1878, and described at that time in ENGINEERING—this structure has 16 spans and a total length of 4,210 ft.; the Kortri Bridge, over the Indus, made up of 350-ft. spans, and having a total length of 1,948 ft.; the Kistna Bridge on the Madras and Southern Mahratta Railway, and the Roopnarain Bridge on the Bengal-Nagpur Railway, which is composed of 300-ft. spans, the former being 3,684 ft. long and the latter 2,632 ft.; and the Attock Bridge, having a total length of 1,522 ft.



J. Russell and Sons, Photographers.

SIR ALEXANDER MEADOWS RENDEL, K.C.I.E.

Sir Alexander was also, in conjunction with his partner, the late Mr. F. E. Robertson, responsible for the design of the Gokteik Viaduct on the Burma Railway Company's system, having a height of 320 ft., which makes it specially notable. The detail drawings for this structure, however, were made by the Pennsylvania Steel Company, according to Sir Alexander's specification and under his supervision.

Naturally, Sir Alexander, as consulting engineer to the Secretary of State for India, had considerable influence on the administration of the railways, and in this connection it is noteworthy that long before railway authorities in this country had awakened to the importance of precise statistics of traffic, he introduced, in 1871, a system for accumulating data as to receipts and costs per train-mile, passenger mile and ton-mile and other similar facts, to enable a closer analysis to be made of the performance and efficiency of the various lines and companies. In this work he had the co-operation of General Sir Richard Strachey, and the system was known throughout India as "the Rendel statistics."

Sir Alexander was awarded the high distinction of Knight Commander of the Indian Empire in January, 1887, a fit reward for the thirty years' work he had done up to that time in India. He became a member of the Institution of Civil Engineers in 1862, and was a member of Council 1880–83. He had an inherent objection to anything which savoured of advertisement, and preferred that his work rather than his words should exert its influence on the development of engineering. He, however, made many friends, but to him his work was the great attraction in life, and it is characteristic that when, in 1912, his partner, Mr. Robertson, died, during the construction of the Hardinge Bridge, he, although then 84 years of age, resumed harness, and devoted himself with surprising energy to the work. He attended his office to within five days of his death.

Prior to Mr. Robertson becoming his partner, he had the co-operation of his son, William Stewart Rendel, who was his partner from 1888 until his

death in 1898, and of another son, Mr. H. Wedgwood Rendel, from 1898 until his death in 1903. Mr. Robertson was a partner from 1888 until 1912, and after his decease Sir Alexander took as partners Mr. Frederick Palmer, C.I.E., and Mr. Seymour B. Tritton, the latter having been chief of his staff for many years. Since 1914 Mr. Palmer and Mr. Tritton have been associated with Sir Alexander as consulting engineers to the Secretary of State for India.

Sir Alexander, in 1853, married Eliza, the eldest daughter of the late Captain Hobson, R.N., the first Governor of New Zealand, and she predeceased him by barely two years. Of their issue there survive his eldest son, Mr. James M. Rendel, who is Chairman and managing director of the Assam Bengal Company and Dr. Arthur Rendel, M.B., B.C., a daughter, who is the wife of Mr. Halsey Ricardo, the well-known architect, and another daughter, who is the wife of Dr. Roland Danvers Brinton, B.A., M.D.

LITERATURE.

Methods of Metallurgical Analysis. By Charles H. White, Assistant Professor of Mining and Metallurgy in Harvard University and in the Massachusetts Institute of Technology. London: Constable and Company, Limited. [Price 10*s.* 6*d.* bound.]

To deal with the whole domain of metallurgical analysis, including assaying in a duodecimo volume of 356 pages, is in itself a very difficult task, and we do not understand, why the author felt advised to include in it chapters on the analysis and the calorific power of coal (18 pages), on petroleum (11 pages), and on gas analysis (10 pages). For some reason, moreover, these additions have been inserted between the chapters on the platinum metals and clay analysis. After explaining methods for the determination of some of the minor and some rarer metals, one page on testing lubricating oils (in which there are exactly 6 lines on viscosity) and 5 pages on the examination of boiler water are again interposed before the chapter on the detection of metals and the tables, which with the index conclude the volume. These unnecessary additions make one a litttle suspicious as to one of the best features of the work, the exceedingly concise, clear style. In the body of the volume we read, *e.g.*: "Weigh 1 gramme of the ore, transfer to a 200 c.c. flask, add 15 c.c. of hydrochloric acid—ignite and weigh as . ." It is only by adopting this "direct statement without regard to literary style" that Professor White has been able to accomplish his task. We do not find fault with the style at all, but we doubt whether the notes given sufficiently embody the qualifications, which almost any analysis requires in view of the possible presence of common or rare companions of the metal in question. "Explanatory notes have been introduced where they are most needed by the beginner, but are so subdued as not to annoy the experienced reader." Nobody will complain about being annoyed, we think. References are fairly frequent in some chapters—there are no main divisions in the book—but are altogether missing in a good many other chapters, and the inexperienced student will not find much help in the four pages of "general references," titles of books which are offered in alphabetical order of the authors' names without any guidance. These titles, at any rate, are given with the dates of publication, however, which the footnote references to periodicals mostly do not mention.

Professor White states in his preface that he has "brought together those methods in metallurgical analysis which, owing to their fitness, seem to have been most generally adopted in American metallurgical laboratories." That was evidently quite sufficient for the compass of the volume, but it is not sufficient for the subject. The use of modern organic reagents is only mentioned in the case of dimethyl glyoxime for the separation of nickel and cobalt. A good many other organic reagents have proved very useful in the metallurgical laboratory. There are many commendable features in the treatment of the subject. A chapter generally begins with an outline of the process to be explained, states the reagents required and their concentrations, describes the apparatus, and gives clear directions as to the mode of procedure and calculations. The frequent cross-references are another good point. On the other hand, we cannot overlook that the preface is dated January 2, 1915, and that the literature quotations seem to close with 1914, whilst the date of publication is 1917.

BOOKS RECEIVED.

The Post Office London Directory for 1918, *with County Suburbs.* London: Kelly's Directories, Limited. [Price 45*s.*]

Cours de Mécanique rédigé conformément aux nouveaux programmes des Ecoles nationales d'Arts et Metiers. Par L. Guillot. Tome quartrieme. *Moteurs a Gaz et a Pétrole; Regularité de la Marche des Machines; Mesure des Forces et du Travail.* Paris et Liege; Ch. Beranger. [Price 21 francs.]

Shrapnel Shell Manufacture. By Douglas T. Hamilton. New York: The Industrial Press.

The National Physical Laboratory. Notes on Screw Gauges by the Staff of the Gauge-Testing Department. Enlarged issue, II. Teddington: W. F. Parrott, The Causeway. [Price 2*s.* 6*d.*]

The Strength of Structural Elements. By Ernest H. Sprague, Assoc.M.Inst.C.E. London: Scott, Greenwood and Son. [Price 4*s.* net.]

Soldiers and Labour. By Bart Kennedy. With ten Illustrations by Joseph Simpson. London, New York and Toronto; Hodder and Stoughton. [Price 1*s.* net.]

The German Terror in France. By Arnold J. Toynbee. London, New York and Toronto; Hodder and Stoughton. [Price 1*s.* net.]

The Education of Engineers. By Herbert C. Taylor. London: G. Bell and Sons, Limited. [Price 2*s.* net.]

Modern Coking Practice. By J. F. Christopher, Wigan Coal and Iron Company. *Including the Analysis of Materials and Products.* By T. H. Byrom, F.I.C., F.C.S. Second Edition in two volumes. Vol. I, *Raw Materials and Coke.* Vol. II, *By-Products.* London: Crosby Lockwood and Son. [Price 7*s.* 6*d.* net each volume.]

Transactions of the Institutions of Naval Architects. Vol. LIX. Edited by R. W. Dana, M.A., M.Inst.C.E., Secretary of the Institution. London: Henry Sotheran and Co., 43, Piccadilly, W.C. 2.

Queensland Railways; Report of the Commissioner for Railways for the Year ended June 30, 1917. Brisbane; Arthur James Cumming, Government Printer.

Modern Workshop Practice; A Manual for the Use of Engineers, Apprentices, and Students in Technical Institutes. By Ernest Pull. Fourth Edition, Revised and Enlarged. London: Crosby Lockwood and Son. [Price 6*s.* net.]

The Third Great War Number of the Fleet Annual and Naval Year Book, 1917. Compiled by Lionel Yexley. Twelfth year. London: Chapman and Hall, Limited. [Price 4*s.* net.]

Journal of the Society of Glass Technology. Vol. I, No. 3. Published quarterly. The Society, The University, Sheffield. [Price 7*s.* 6*d.* to non-members.]

University of Illinois: Engineering Experiment Station. The Effect of Mouthpieces on the Flow of Water through a Submerged Pipe. By Fred. B. Seely. Urbana, U.S.A.: Engineering Experiment Station.

"Verbal" Notes and Sketches for Marine Engineers: A Manual of Marine Engineering Practice. Intended for the Use of Naval and Mercantile Marine Engineers of all Grades, and Students, Foremen Engineers, &c., and is specially Compiled for the Use of Engineers Preparing for Examinations of Competency at Home or Abroad. By J. W. M. Sotheen, M.I.E.S. Ninth edition, greatly enlarged in both text and illustrations. Glasgow: James Munro and Co., Limited, 60 Brown Street. [Price 25*s.* net.]

Links with the Past: A Brief Chronicle of the Public Service of a Notable Institution. By A. F. Shepherd. With Reproductions from Old Prints and Photographs and Illustrations by E. Coffin. London: The Eagle and British Dominions Insurance Company, Limited, British Dominions House, Royal Exchange-avenue, E.C.

University of Illinois Bulletin. No. 97. *Effects of Storage upon the Properties of Coal.* By S. Parr. Urbana, Ill.: University of Illinois. London: Chapman and Hall, Limited. [Price 20 cents.]

Efficiency Methods: An Introduction to Scientific Management. By M. McKillop, M.A., and A. D. McKillop, B.Sc.(Eng.). London: George Routledge and Sons, Limited. [Price 4*s.* 6*d.* net.]

A Fraudulent Standard: An Exposure of the Fraudulent Character of our Monetary Standard with Suggestions for the Establishment of an Invariable Unit of Value. By Arthur Kitson. London: P. S. King and Son, Limited. [Price 7*s.* 6*d.* net.]

Heat-Drop Tables. H.P. Gauge Pressures. L.P. Absolute Pressures. Calculated by Herbert Moss, M.Sc., A.R.C.S., D.I.C., from the formulæ and Steam Tables of Professor H. L. Callendar, M.A., LL.D., F.R.S. London: Edward Arnold. [Price 5*s.* net.]

Swedish Enterprise in Switzerland.—At the instance of the Gas Accumulator Company, Stockholm, a Swedish-Swiss company, has been formed under the style of the "Aga Company" (Aga being short for Aktiebolaget Gas Accumulator) with works in the vicinity of Basle. The company will take up the manufacture of dissolved gas which, owing to the prevalent shortage of fuel, is being used on an increasing scale for lighting and power purposes.

INDUSTRIAL NOTES.

The Glasgow Herald, published in a district where industrial unrest is great, is doing well in initiating a campaign for a national expression of public opinion on the Labour situation, and we are glad to learn that the Lord Provost of Glasgow is beginning this campaign of public meetings and hope that other heads of municipalities will follow his example. Our contemporary says:—

"It is unfortunate that the situation on Clydeside should be misunderstood and misrepresented—as it has been by sections of the Metropolitan press—when the object is the legitimate one of informing and patriotically influencing public opinion. It must be that distance lends illusion to the view, for no one in contact with the local conditions would dream of arguing that the dispute with the Amalgamated Society of Engineers over the Man-Power Bill is the cloud that darkens the industrial horizon and is big with the national fate. That dispute counts. It is, however, not only unjust to the loyal members of the Amalgamated Society of Engineers, but a travesty of the historic facts to suggest that the disgraceful proceedings which wound up Sir Auckland Geddes' meeting—and the similar proceedings which have taken place elsewhere—are in the direct line of descent from so-called 'broken pledges,' the Government's alleged inept handling of Labour troubles, and the quarrel with the Amalgamated Society of Engineers over the technique of procedure. Great events may have small occasions. In the present instance the origins of trouble are a blend of Syndicalism and Pacifism, which has been in ferment for very many months, and to which Bolshevism has recently added its unholy leaven. The truth has been notorious ever since the deportations first drew attention to industrial developments on the Clyde, and it is certain that the federated trades, who are now shamelessly challenging the public eye, would have produced their audacious claims if the Man-Power Bill had never been drafted.

The issue raised is a far bigger one than the right of the Government to revise its pledges in the light of altered circumstances. It is nothing less than this—that the constituted authorities of this country shall resign their functions into the hands of the Lenins and Trotskys, who in the meantime are obscurely anonymous. Well, that is an issue which the people, and in particular the working classes, of Scotland and England can recognise as a tangible one. Whatever its demerits, it fills the eye. It is impudence raised to the *n*-th power, and but for the Trotsky regime in Russia we might have called it unparalleled. Now, however, that they can regard it in its naked audacity, what do our working men think of it? Some of our working women, to the number of 4,000, have telegraphed from Georgetown their candid opinion. 'Horror and indignation' is the phrase they employ, and we do not believe Labour generally will disagree with them. It may well seem to loyal Labour, however, as it seems to us, that more is required than mere acquiescence in repudiatory resolutions, though we hope to see these carried at town's meetings of all classes of citizens. The Labour movement, even more than society generally, is being parasitically attacked. It has given hospitality to these alien revolutionary organisations, and its development on constitutional lines is threatened with overthrow. If the trade unionists do not meet the challenge which has been cast to them as well as to the Government, if the democracy does not revolt against this attempted dictation by an impudent minority, it will be matter for surprise as well as regret. But we believe that if Glasgow and the other great communities are given the opportunity to declare a frank mind and to organise their resources against this insolent revolt, Mr. Ramsay Macdonald's 'German friends' will not derive much satisfaction from the turn of events. An emphatically expressed public opinion, for which here the Lord Provost may furnish an immediate opportunity, will go a long way to prove that the mere "will to strike" of a numerically insignificant faction is an impotent force.

Public opinion, however, must have the firm leading of a Government that not only realises the potential gravity of the situation but is prepared to enforce its will."

The Minister of Labour has appointed an Iron and Steel and Kindred Trades Central Advisory Committee (Employers), to advise and assist the Ministry of Labour on questions arising in the administration of the Employment Exchanges, which affect employers in that industry. The committee held their first meeting at the Employment Department at 11 a.m. on Wednesday, January 23. Mr. W. C. Bridgeman M.P., Parliamentary Secretary to the Ministry of Labour, was present and, in a speech welcoming the members of the committee, explained the functions of the committee and their relations with the Local

Advisory Committees which are now being set up in connection with individual Employment Exchanges or groups of exchanges. Mr. J. J. Burton, J.P., of the Cleveland Ironmasters' Association, was elected chairman, and Mr. F. W. Gilbertson, of the South Wales Siemens Steel Association, vice-chairman of the committee. The committee then received and considered a general statement of the work of the Employment Exchanges, and discussed a proposal that managers of exchanges, when selecting applicants to fill vacancies, should give a preference, other things being equal, to men who have been discharged from His Majesty's forces owing to wounds or other disability. It was agreed that the application of this principle in the iron and steel trade should be discussed at a joint meeting with the corresponding Operatives' Committee.

The Government have considered the question of remuneration of seamen in cross-Channel steamers under the control of the Railway Executive Committee, and as these men are subject to risks not incurred by shore labour, they have decided that the total emoluments (including war bonuses) of men on railway-owned transports and cross-Channel steamers shall be made up to an amount equivalent to the national standard rate of pay as determined by the Ministry of Shipping upon the recommendation of the National Maritime Board, to date from October 6, 1917.

A large number of cases arising out of the Orders under which a bonus to munitions workers has been given have been referred by the Ministry of Labour to the Committee on Production or to the Special Arbitration Tribunal. Several of the cases have already been heard in Glasgow and in London, and decisions have been given in the five following cases: Messrs. Yarrow and Co., Limited, light platers engaged on heavy plating work and riveters and caulkers who are paid allowances for riveting boilers and for expanding tubes are entitled to the 12½ per cent. bonus. Messrs. William Beardmore and Co., Limited, Dalmuir, boiler makers employed in the gun-mounting department receive a bonus of 7½ per cent. on earnings; water testers also receive the same bonus on earnings. The Mond Nickel Company, Ltd., Clydach, engineers, moulders and electricians are entitled to receive the bonus of 12½ per cent. Messrs. Baldwins, Limited, Panteg, engineers and ironmoulders are also entitled to receive the same bonus.

Mr. F. G. Kellaway, M.P., Parliamentary Secretary to the Minister of Munitions, in a recent letter to his constituents, said that the 12½ per cent. bonus removed a grievance which was widely felt. The great majority of those who had denounced the Government for its action on the bonus did not seem, he stated, to have realised how great an industrial revolution was accomplished when the leaving certificate was abolished. Its abolition gave back to the workman the right to sell his labour in the highest market, and it was inevitable that the Government would have to face a general demand by the munition workers for an increase in their wages. Two courses were open, to let the situation solve itself by individual bargaining between employers and men, or to deal with it on general lines. The ultimate cost to the State of the first course would have been as great as that of the 12½ per cent. bonus, perhaps greater, and the irritation and disorganisation would have been much more serious. The Government selected the second course. At first, it was intended that the bonus should apply only to skilled men on time rates, since they had suffered by being kept on time work, whilst the semi-skilled and unskilled men working piece-work were earning higher wages. But after the issue of the first order, the latter men presented what was, in his view, an irresistible case. Mr. Kellaway thought that the prejudice against the bonus arose largely from the belief that the munitions workers were in receipt of fabulous wages; he held, however, that the wages of the majority of these workers, even with the bonus added, had not done more than kept pace with the increase in the cost of living.

Many Norwegian residents in England, says *The Anglo-Norwegian Trade Journal*, have at times been disappointed at the attitude of the Norwegian Socialists, who from the beginning of the war have proclaimed that peace must be procured at all costs. Therefore it is very pleasing to see that the party has refused to consider the offers of cheap coal and coke made to it by emissaries from the German Socialist party, backed by the German Government. Similar supplies to Socialists in other neutral countries have been taking place for some time, and it is particularly creditable to the Norwegian workmen that they have rejected the proposal in an uncompromising manner, when it is borne in mind (1) that the price of coal for household purposes must be about 20*l.* per ton, and (2) that there exists in Norway at the moment a unanimous feeling of bitter disappointment regarding the stoppage for many months past of all supplies of petroleum, petrol, fishing nets, tackle, &c. (for which supplies facilities were guaranteed to Norway, "British home needs permitting").

Two German Socialist emissaries made the offer, provided the Norwegian Socialist press would undertake to write favourably of the German Government, and provided the Norwegian Socialist party would work for the abrogation or modification of the fish agreement between Norway and England. The Norwegian reply was that no agreement bringing the Norwegian workmen economic gain would be accepted if it interfered with Norwegian national interests.

The British Labour party will appreciate the kind of "independent attitude" which the German Socialists are taking up apart from the German Government in the present world crisis.

With reference to the military employment of the older classes of the German Landsturm, *Vorwärts*, for November 14, says that the Prussian Ministry of War informed Dr. Müller, a member of the Reichstag, that no undertaking was given in the Reichstag to the effect that these classes were only to be employed as guards for prisoners of war. No deviation could be allowed from the regulations which required that even the men over 45 years of age must serve a minimum of six months in the very front line. During the Reichstag proceedings, it had simply been stated on behalf of the Ministry of War that a release of the old classes might take place on the ground that they would be urgently needed for guarding prisoners of war.

It is stated in *Vorwärts*, for October 30, that in the course of the general meeting of the Berlin and District branch of the Engine Drivers and Stokers' Union, Herr Jacobi, representing the union, spoke of the very frequent references which were being made to the great advances in workers' earnings. He pointed out that, according to the inquiries made by the Imperial Statistical Office as to earnings in certain trades selected as typical, for the months of March and September, 1914, 1915 and 1916, the average daily earnings for male workmen rose from 5.12 marks (5*s.* 1½*d.*) in September, 1914, to 7.55 marks (7*s.* 6*d.*) in September, 1916. Wages remained far behind the increase in the cost of food and necessary articles, which in many cases amounted to 600 per cent. and more.

In its issue for October 11, *Die Konjonktur* reproduces an article from the Metal Workers' Journal, stating that in the Brunswick metal factories, as in other factories throughout Germany, notices were distributed in August last calling upon the workpeople to go out on strike on the 15th of the month. The Brunswick operatives went out on strike, when orders of the military authorities were posted up in the streets, requiring work to be resumed, in default of which strict conditions of martial law would be introduced. The instigators of the "general strike" were the first to return to work, whilst the mass of the strikers betook themselves to their meeting-place, where, however, the authorities would allow no assembly to take place. Meanwhile, the special military court was working day and night, and the arrests and trials numbered over a hundred. Terms of imprisonment up to ten months were imposed; workers between the ages of 17 and 48 were brought under military control and were ordered to perform certain work for which they would receive military pay. Large numbers of workpeople gave up their membership of the local trade organisations, especially that of the Metal Workers.

According to *Vorwarts* for October 22, the organ of the General Committee of the Social Democratic Unions points out that very large bodies of workers in munition works are earning by the most severe exertions weekly wages of from 25 marks to 40 marks (about 1*l.* 5*s.* to 2*l.*). It further observes that if workers' war wages are to be subjected to examination, so should the war profits of employers.

We read in *Vorwärts* for November 15 that a densely crowded meeting of the German Railway Workers' Union was held on November 13, when the president of the union stated that the last wages advance of 10 per cent. on July 10, 1917, was absolutely inadequate under present conditions. At the present time, under the official wages scale, unskilled workers received a commencing wage of 4.20 marks (4*s.* 2½*d.*) per day, in Berlin (which had the highest rates); after twelve years' employment the man reached the maximum of 5.40 marks (5*s.* 5*d.*). The commencing wage of skilled workers was 5.50 marks (5*s.* 6*d.*), rising to a maximum of 6.70 marks (6*s.* 8½*d.*). The lowest rates for unskilled workers, paid in small towns, were at the present time 3.30 marks (3*s.* 3½*d.*), rising to 4.50 marks (4*s.* 6*d.*). At a former meeting, held on October 11, a fresh increase of 25 per cent. had been demanded The meeting of November 13 unanimously passed a resolution demanding that a minimum daily wage of 5 marks (5*s.*) exclusive of overtime, cost of living, and other supplements, be accepted by the State Railways as a base, additions to this minimum to be made in the towns and areas where the cost of living was high. Increased prices were not confined to food, but extended to all necessary articles.

Coal shortage is compelling restrictions in more and more trades, says the *Vossische Zeitung* for October 23, and the dyeing industry must now submit to a very substantial curtailment of its activity. No sensible man would raise one single word in protest against this procedure, as it would be vain and wrong at this time to cry out against the stern compulsion of necessity, were the restrictions imposed in such a way that large firms did not benefit by the one-sided preferential policy which is bound to cause the most serious damage to the medium and small undertakings. It is intended, says the German Journal, to close 30 out of 34 dyeing works in Berlin. That is to say, instead of creating, as would have been just and fair, a common co-operative organisation, few large firms are given an uncommonly valuable monopoly at the expense of the medium and small firms. The sole concession that is made to the eliminated firms is the offer to grant them a commission on the businesses which they bring to the few firms. In other words, the sole source of revenue left to them for the future is the retail business, and merely a portion of that, for the shop trade is sure to ebb away as soon as the public learns of the closing of the works of the shops concerned. They are not to receive a penny of compensation for the loss of the entire wholesale business, including that connected with army contracts, and although many charges, such as rent, interest on capital, interest on bank advances, will continue to accrue. On the other hand, the outlay incurred by the few large firms for necessary developments is negligible in proportion to the magnitude of the orders which will flow to them henceforth from the customers of the closed works.

The *Frankfurter Zeitung* for November 6 publishes an article on the increase of capital in the aniline industry. After calling attention to the great part played by the chemical industry in the successful conduct of the war, the writer proceeds to point out that war conditions have necessitated considerable changes and extensions, and the introduction of new plant on a large scale in many of the works. This has involved the sinking of an appreciable amount of new capital, which has been covered partly by the Government and partly by the undertakings themselves. Thus, the three largest members of the combine formed in May, 1917, have each raised their capital from 54,000,000 marks (2,700,000*l.*) to 90,000,000 marks (4,500,000*l.*), the new shares being offered to the old shareholders at 107 per cent. Other increases are from 19.8 to 32 or 33 million marks, and from 16 to 24 or 25 million marks. It is expected that some 150,000,000 marks (7,500,000*l.*) of new capital will be raised altogether, but the total will not cover the expenditure on new plant, so that the Government will have to provide further assistance. The writer concludes by pointing out that this extension of capital in the aniline industry is the third recent instance of such extension on a large scale, the other two being in banking and in mining.

UNITED STATES STEEL AND PIG-IRON OUTPUT.—We read in *The Iron Trade Review*, Cleveland, Ohio, that the steel-ingot production in 1917, as estimated by the American Iron and Steel Institute, will be 42,600,000 gross tons. The pig-iron output, our contemporary estimates, will be 38,500,000 tons. The former figure will mark a new record; the latter will mark a drop from the total pig-iron production of 1916. The ability of the steel industry to make a new production record in the year in which the United States entered the war will arouse greater satisfaction among that country's friends than among its enemies. Germany's steel output sagged heavily after she opened hostilities, and yet she had a clearer appreciation than any other nation of the colossal tonnages of iron and steel which modern warfare demands. German "efficiency" could round up an immense, trained army overnight, but failed to mobilise simultaneously her industrial forces. America, with an army to find and equip, and with the handicaps which her inexperience and unpreparedness entailed, was able, at the same time, the *Review* states, to keep her steel furnaces in operation and to surpass her 1916 mark, itself a record. The decline in pig-iron output from 1916 is comparatively slight and is due to the difficulties met in assembling raw materials. The *Review* concludes by stating that the year's record production inspires confidence in the future. Germany's steel industry, when pitted against America's, is fighting a losing battle.

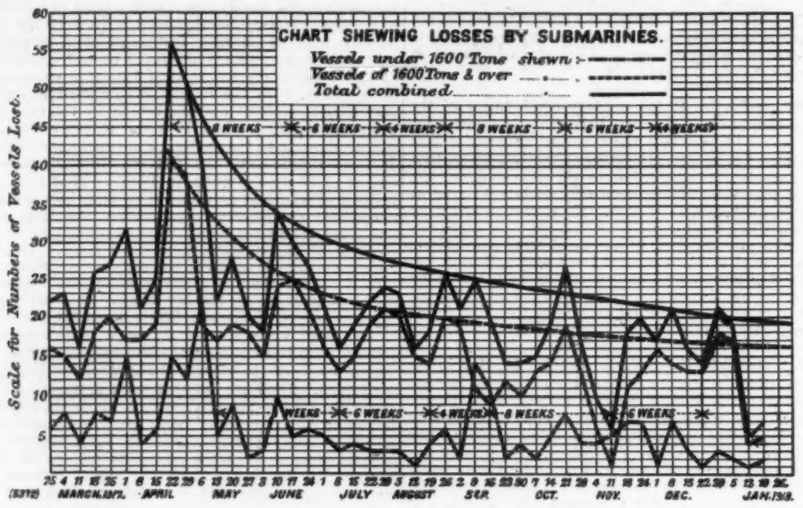
SUBMARINE WAR.

To the Editor of Engineering.

Sir,—With reference to the various letters, charts, &c., which have been appearing in your columns showing the effect of U-boat warfare on our shipping, I venture to think that the enclosed chart may also be of interest to your readers, and, as it is based on the information given in the newspapers from week to week, I do not suppose there will be any objection to your publishing it should you desire to do so.

The chart is self-explanatory, but there are two points which call for special attention :—

1. A fair curve drawn through the *humps* of the chart or total combined losses or for losses of vessels of 1,600



tons and over, gives a very rough approximation of the rate on which these losses are being reduced. At the present rate, it appears that each month sees the average losses per week reduced by one, in other words, if our average losses per week for this month are, say, 12 vessels, then next month, at the present rate of reduction, the average losses per week should be 11 vessels.

2. The chart for vessels of less than 1,600 tons is very irregular, but in the chart for vessels of 1,600 tons and over the *humps* and *hollows* seem to occur at definite intervals of eight weeks, six weeks and four weeks, as indicated. This may be only coincidence, but it is curious to note that this has been the case during the past nine months.

I have taken special interest in this matter, as I sailed for New York on April 15, arriving on April 25, 1917, during which period the maximum losses occurred, viz., 56 vessels per week.

Yours faithfully,
Thomas N. S. Dickson.

Dalmuir, January 17, 1918.

THE VALUE OF SUPERHEATED STEAM IN LOCOMOTIVES.

To the Editor of Engineering.

Sir,—As the writer of one of the very first letters suggesting the application of locomotive superheating to modern railway requirements in this country—which letter, by the way, was published in Engineering dated May 17, 1907, page 655—I should like to add my quota to the discussion now going on in your columns.

It is, I think, sometimes forgotten that superheating, like compounding, is economy, not power. Advantage may be taken of it to increase the power relatively to the size of the boiler, but that is another matter. Other things being equal, superheated steam cannot of itself increase the power in the cylinders. Now, an oft-reiterated claim is that an earlier cut-off can be, and ought to be, invariably used in a superheater locomotive than would be necessary in the case of a saturated steam locomotive doing the same work. The question is, to what has this claim any foundation in fact? It appears to me to need some qualification. At the same point of cut-off, the expansion line of superheated steam falls more steeply than that of saturated steam, with, of course, a consequent drop in temperature and—what is more important—pressure. The higher the degree of superheat, the more pronounced will these conditions be. Hence, with highly superheated steam, there is a certain loss of work during the expansion period as compared with "wet" steam, to offset which loss it is only reasonable to suppose that, if the cylinders be enlarged, then the boiler pressure must not be reduced, or, alternatively, that if the steam pressure be lowered, then a somewhat later, not an earlier, cut-off, must be employed in order to get the same power as before. The more common practice has been to use larger cylinders in conjunction with reduced boiler pressures, and whilst this practice has resulted in an appreciable measure of economy in coal and water consumption, yet it seems to me to be out of the question, unless the tractive potentialities of the superheater engine be sacrificed, with the regulator half open and with the reversing lever well notched up. Almost every locomotive has to be forced on some portion or other of its daily run, owing to gradients, load, &c. Consequently, forcing an engine does not of necessity imply that the boiler is too small. To get more power, even with a superheater locomotive, you must use more steam; you must raise the M.E.P., and this certainly is not achieved by "pulling the engine in" at such times when a greater horse-power output is demanded from it. From the economic standpoint, it does not signify how much a superheated steam locomotive is forced, since its relative economy increases with the increase in superheat, which follows the augmentation in draught due to working the engine, either generally or temporarily, with a later cut-off. In the case of a saturated steam locomotive, just the opposite takes place. As the quantity of coal consumed per foot of grate area increases, so the quantity of water evaporated per pound of coal decreases; so that, although the total quantity of water converted into steam in a given time is greater, it is obtained by a comparatively wasteful expenditure of the heat generated by the fuel. At the same time the steam becomes wetter and wetter.

Therefore, even assuming a comparison between a superheated steam locomotive and a saturated steam locomotive on a basis of equal weights (as suggested by "Loco., M.I.M.E."), I am still strongly inclined to the opinion that the superheater engine would prove itself to be the more economical of the two machines. It is difficult to see how it could be otherwise than more economical. If the cylinders and steam pressure be alike in both engines, then by working the superheater locomotive with a sufficiently late cut-off it could not only be made to develop more power, but it could be made to do so on a much smaller consumption of coal and water than would, in my opinion, be possible in the case of a non-superheater engine.

On the other hand, excessive economy should not be aimed at. Tractive efficiency comes first, and when it is sacrificed for the sake of economy purely and simply, then a blunder, I consider, has been made. For this reason, there ought to be no hesitation to work a superheater locomotive at a later cut-off than either theory or economy might dictate as advisable. Greater power can only be obtained by getting more steam into the cylinders—not by trying to keep it out. This may mean more coal, but the increased consumption of fuel will, if highly superheated steam be used, still be low relatively to the better work done at the draw-bar.

"Loco.'s" letter in your issue of the 11th inst. is in reality a little treatise on the whole subject, and, as such, it is decidedly welcome. I agree with Mr. A. J. Brewer's plea for plenty of thermal storage, in the form of hot water in the boiler.

I am, Sir, yours faithfully,
F. W. Brewer.

"Strathmore," Walkern-road, Stevenage, Herts.,
January 27, 1918.

AIRCRAFT CONSTRUCTION.

To the Editor of Engineering.

Sir,—I venture to reply to Mr. George's courteous letter. In the absence of particulars I assumed rather the worst conditions, that of adding the ¼-in. strips of three-ply wood to the underside of the box ribs. The fact that they are placed between the box ribs makes the alteration of still less importance, and although I do not pose as an expert, I can assure him in this position they will have no effect whatever on the "slip stream."

It is rather unfortunate that the quantities involved are so small, as it does not tempt one to go deeply into figures, but from particulars given taking the loading at 6 lb. per square foot—0.4 lb. of added weight would increase the wing area by 0.0666 sq. ft. in order to keep the same angle of incidence, consequently at 100 m.p.h. velocity it would increase the horse-power by 0.013, an amount which the most slight inclination of the elevators would probably neutralise.

My figures are of necessity only approximate, and I have had to assume an aerofoil coefficient of my own.

It is also unwise to limit weight of pilot to 140 lb., and the Board of Trade has fixed the average at 165 lb. for ordinary persons. So in this matter there is always to be left a large margin.

Yours faithfully,
Ernest L. Comfort.

31, West Park-road, Kew Gardens,
January 26, 1918.

Sheffield Association of Metallurgists and Metallurgical Chemists.—Temporary accommodation has been found for the association at the Royal Victoria Hotel. The opening meeting will be held in the Assembly Room, on Monday, February 4, at 8 p.m., when the president, W. H. Hatfield, D.Met., will deliver an address dealing with the rules, aims and objects of the association; followed by J. Evans, F.I.C.; J. C. W. Humfrey, M.Sc., B.A.; and T. Swinden, D.Met., who will report on the work of the House, Proceedings and Business Committees respectively. After this meeting the association's headquarters will be open for the use of members and associates each Monday, at 6 p.m.

Cutting Double Helical Gears.—In the article by Mr. Joseph Horner on "The Arrangement of Machine Shops" which appeared on page 679 of our issue of December 28 last, when dealing with the department of Messrs. David Brown and Sons (Hudd.), Limited, devoted to the cutting of double helical gear, it was stated that "the machines used are of a special type of which Messrs. Brown hold the sole patent rights." This statement should read as follows: "The machines used are of a special type. In these machines the teeth of the gear are generated by means of rack-shaped cutters (for which Messrs. Brown hold the sole patent rights) which reciprocate at an angle corresponding with the helix angle of the tooth."

Personal.—Messrs. Sulzer Brothers announce the formation of a new company under the title of "Compagnie de Construction Mecanique Procédés Sulzer," with offices at 12, Rue Boissy d'Anglas, Paris, this being a combination of their French business with the following firms: Compagnie des Forges and Aciéries de la Marine and d'Homécourt, à St. Chamond (Loire); Société Anonyme des Hauts-Fourneaux and Fonderies de Pont-à-Mousson, à Pont-à-Mousson (Meurthe and Moselle); Société Anonyme pour la Fabrication des Cylindres de Laminoirs de Frouard, à Frouard (Meurthe and Moselle); Société Anonyme des Aciéries de Micheville, à Micheville (Meurthe and Moselle); MM. E. Capitain Gény and Co., Société en commandite simple, à Bussy (Haute Marne); Fonderies de Bayard et St. Dizier, Société Anonyme, à Bayard par Laneuville à Bayard (Haute Marne). The new company has acquired a licence to manufacture Sulzer marine Diesel engines, stationary Diesel engines, centrifugal pumps and refrigerating machinery, and works are being erected at Drancy, near Paris.

The Peter System of Rack Railway.—A type of rack railway for steep gradients, due to Mr. H. H. Peter, of Zürich, is described by Mr. S. Abt in the *Schweizerische Bauzeitung* of January 5 and 12, 1918. The rail is gripped between two spur wheels lying in the horizontal plane of the railhead, so that the teeth engage horizontally. The novelty of the type lies in the gearing, the brake mechanism and in the end section of the rack laid at places where the rack line passes into an ordinary adhesion line. The rack rail is widened and so developed into a horizontal rack that the teeth are exactly opposite one another; the rail foot has a width of 100 mm. or more, the web height is 200 mm., and the width of the head 100 mm.; the rack weighs about 50 kg. per metre. These dimensions refer to the line Karlsruhe-Dreikreuzberg, which was under construction when the war broke out; another line is being built for the Monte Maggiore; the gradient of the former line is 50 per cent. The drive of the engine is through a friction coupling from the motor shaft, toothed gearing and counter shafting to the conical wheels which turn the spur horizontal wheels above mentioned. On the vertical shaft of one of these wheels, a little above the latter, is mounted the spur wheel which comes into action when the car is to leave the rack and to enter the ordinary adhesion track. The end section of the rack is made a little higher than the rack itself, and is provided with teeth on one side only; this rail section itself is so held by spiral springs that it has a little longitudinal play, parallel to the track; the teeth on the end section and on the end of the rack proper are more rounded off than the other teeth. In this way the teeth are enabled to come into mesh, and the transition is rendered more smooth. The Swiss Locomotive and Engine Works, of Winterthur, and the Iron Works von Roll, of Bern, have taken up the construction of this rack railway.

RECENT DEVELOPMENTS IN BALANCING APPARATUS.*

By N. W. AKIMOFF, Philadelphia, Pa., Member of the Society.

SINCE my paper was presented on the subject of "Dynamic Balance,"† certain improvements have been made in the machine there described; and an entirely new machine based on new methods of balancing has been developed.

The principle of the original machine is indicated in Fig. 1, which shows a lathe bed which takes the form of a beam hinged at one end and supported by a spring at the other. The body to be tested must first be brought into static balance, after which it is rotated in bearings supported by the beam. If the body is dynamically unbalanced its rotation will cause the beam to vibrate in a vertical plane with a period of oscillation equal to the period of rotation of the body.

Fig.1. SQUIRREL-CAGE TYPE OF DYNAMIC BALANCING MACHINE.

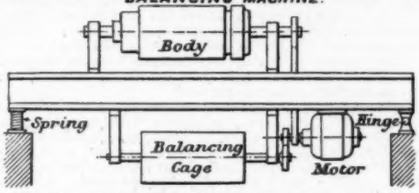
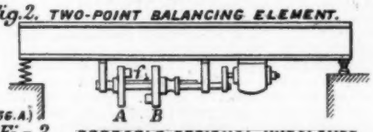
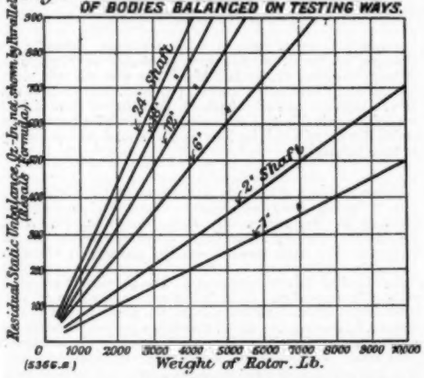


Fig.2. TWO-POINT BALANCING ELEMENT.



(5366.A.)

Fig.3. PROBABLE RESIDUAL UNBALANCE OF BODIES BALANCED ON TESTING WAYS.



(5366.B.)

Suspended from the beam is a second body in the form of a so-called squirrel cage consisting of two circular discs carrying an even number of rods so arranged as to slide in holes in the discs. The cage rotates in unison with the body to be tested and a state of unbalance in this body introduces a centrifugal couple which is neutralised by displacing the rods in the cage until an equal compensating couple has been introduced. The distances that the rods are displaced serve as a measurement of the amount of unbalance to be provided for and counterbalanced in the piece under test.

The improvements upon this original machine, referred to above, are as follows:—

(*a*) The substitution for the cage of a two-point element consisting of two discs, A and B, each with a pin projecting from its face, as shown in Fig. 2. The disc A is fixed to its shaft and the disc B is arranged to slide on the shaft through the use of a feather key *f*. It is clear that when the two discs are in contact they will balance each other; but when separated they will introduce a certain centrifugal couple according to the weight of the pins and the distance between the discs, which latter can be varied while the apparatus is in motion.

(*b*) A planetary arrangement by which the relative angular position of the body and the discs (or cage) can be varied while the machine is in operation.

(*c*) The application of a principle whereby the discs (or cage) may be arranged to answer the problem of static balance as well as dynamic balance.

The new methods which have been developed and applied in a new type of machine for combination static and dynamic balancing will be referred to later.

Static Balance.—As a result of a great deal of study of the problem of static balance, I have been forced to admit, in common with many other engineers, that too much has been taken for granted in relation to this subject. Static balance is not a trifling problem to be solved easily by placing a rotating body on parallel ways or rollers, as has commonly been supposed. While it is true that static balance can be found without much trouble in the case of bodies of light weight or where the operating speeds are comparatively slow, there are other cases which are much more difficult. For example, consider a gyroscope wheel whose weight is about 50 lb. or so, running at, say, 10,000 r.p.m.; or a turbo-rotor whose weight is 10,000 lb. and whose speed is 3,600 r.p.m. Neither of these extreme cases can possibly be handled with any degree of success by placing the bodies on ways; and yet, unless static balance is perfect, no dynamic balancing machine can be expected to give reliable results.

Static Balance by Means of Parallel Ways.—It may be well to point out that in balancing by the aid of parallel ways there is a limit to the load which can be safely borne by the journals in contact with the ways. A safe load for each journal appears to be 750 lb. per inch of width, per inch diameter of journal.* For instance, if the ways are 1¼ in. wide and the journal diameter is 10 in., then each side will carry almost 12,000 lb. without any danger of forming permanent flat spots.

It would be of interest if one could estimate the sluggishness of action of a body on the ways under different conditions. The older theories of rolling friction, as proposed by Coulomb, Morin and Dupuit, do not seem to lead to very reliable results. Résal's formula† is probably much more reliable and is here reproduced in simplified form (steel on steel):

$$f = 0.056 \sqrt{1/(1 + 79/D)},$$

where *f* is the length of the flat contact of shaft with the way and D is the diameter of shaft, both in inches. It appears that the weight does not enter into the formula, and in general its results should not be considered as extending to extremes, but only as characterising the average run of things as they are met with in practice.

The diagram in Fig. 3 has been roughly plotted to illustrate the probable sluggishness or residual unbalance which may remain in a body that has been brought into apparent balance by testing on ways. The chart is based on Résal's formula, and, as it is intended simply to illustrate the meaning of the formula, values have been exaggerated by plotting shafts of small diameter against weights altogether inconsistent therewith. The chart is easily read; for instance, if a rotor weighs 4,000 lb., and diameter of its shaft is 6 in., then the residual unbalance may be as great as 480 oz.-in., or, say, 2½ lb. on a 12 in. radius. It is useless to put a body statically unbalanced to such an extent (or even to 50 per cent. of this) on any dynamic balancing machine. Satisfactory results cannot possibly be derived from such tests. An actual case of residual unbalance, typical of many others, is of a shaft having a diameter of $2\frac{9}{16}$ in., a weight of 66 lb. and a residual unbalance of 0.844 oz.-in. The width of the balancing ways was $\frac{7}{16}$ in. (cast-iron chilled and ground).

Considering the phenomenon of rolling friction from the standpoint of higher theories of elasticity (Hertz), the following tentative formula was derived for residual unbalance:

$$M = 0.0004648\ P \sqrt{P\ D},$$

where M is the residual moment in ounce-inches, P the weight per unit of contact length (that is, per inch of combined width of ways), and D the diameter of shaft in inches (steel on steel). The constant may be considered to be rather tentative, but with the advent of a machine capable of establishing perfect static balance it will not take long to find more reliable values for it.

FIGS.4 & 5. CLAMPS USED IN SECURING STATIC & DYNAMIC BALANCE.

Fig.4.

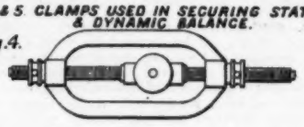


Fig.5.

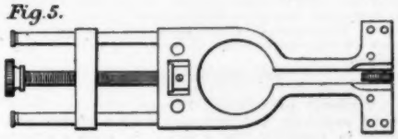


Fig.6. UNBALANCED BODY WITH CENTRE OF GRAVITY LYING IN ITS AXIS.

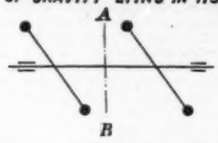


Fig.7. ONE BEARING PIVOTED AND ONE FLOATING.

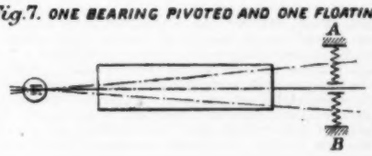
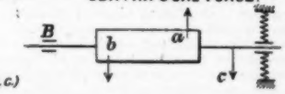


Fig.8. CENTRIFUGAL COUPLE BALANCED BY A CENTRIFUGAL FORCE.



(5366.C.)

Fig.9. BODY SUPPORTED IN SWINGING FRAME FOR SECURING STATIC BALANCE.

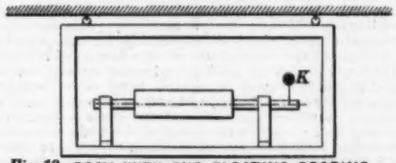
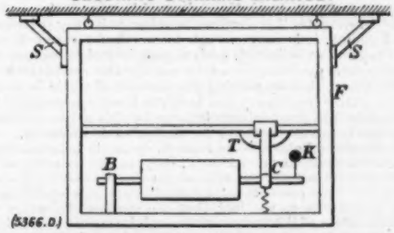


Fig.10. BODY WITH ONE FLOATING BEARING, SUPPORTED IN RIGID FRAME FOR SECURING DYNAMIC BALANCE.



(5366.D.)

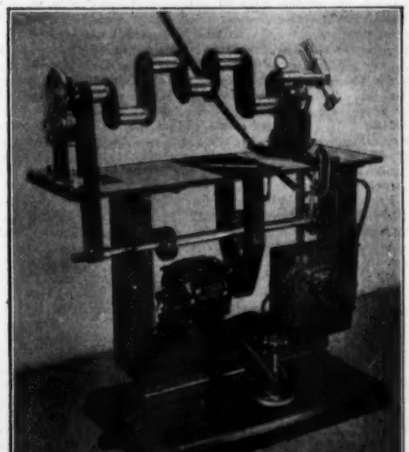


FIG. 11. COMBINED STATIC AND DYNAMIC BALANCING MACHINE.

According to this formula, if an armature weighed 12,000 lb. and had a shaft diameter of 8 in., the sluggishness or residual balance when placed on ways 1 in. wide, would be:

$$M = 0.0004648 \times 6000 \sqrt{6000 \times 8} = 614 \text{ oz.-in.}$$

or over 3 lb. on a 12-in. radius. At 3,600 r.p.m. the centrifugal force due to such residual unbalance would be more than 14,000 lb.

Use of Centrifugal Force in Balancing.—As previously stated, my earlier machine for dynamic balancing was based on the introduction of centrifugal couples, created by the operator to offset the effect of the disturbing centrifugal couple, constituting unbalance in the rotating body. Likewise, a machine for static balancing can be based on the same principle, but long study of the subject has led me to the conclusion that the whole problem of balance, static and dynamic, can be reduced to the principle of a single centrifugal force acting on a properly constrained body. Such centrifugal force can be created by the operator, within a rotating body, by such means as, for instance, the clamps of which two designs are here shown (Figs. 4 and 5). As will be explained, such clamps may be used to offset the effect of static or dynamic unbalance in a rotating body, as the case may be, and to record the extent of such unbalance. They should be carefully made and so calibrated that the centrifugal force may be given as a function of some

* Paper read before the American Society of Mechanical Engineers.

† New Orleans meeting, 1916; Transactions Am.Soc. M.E., vol. xxxviii, page 367.

* According to the writer's remembrance, this figure was first given him by the engineers of the Standard Roller Bearing Company many years ago, and has since been revised by him in connection with other practical data which he was able to gather from different sources.

† Résal, Traité de Mécanique Générale, T. 11, page 6.

linear dimension, read directly or measured by an accurate scale. The first clamp is easier to make and check for accuracy; while the second design is much handier for quick adjustment on the shaft of a rotating body.

Means for Securing Static Balance.—In order to register the effect of static unbalance of a body, or the correction introduced by means of such a clamp as described, the body must be placed in such a condition that its oscillations are emphasised or magnified to an extent that will be visible to the eye; otherwise its unbalance, even if considerable, will not be noticeable and will only result in increased pressure on the bearings. Thus, in a badly unbalanced automobile engine, it is most often possible to pick out a range of speeds where the engine will appear to work smoothly; and many an electric motor with badly unbalanced rotor will apparently run well, simply because its speed may be far away from that which would insure synchronism of the rotation with the oscillation of bearing supports.

Now, suppose we have a frame, suspended as shown in Fig. 9, and capable of a certain period of swinging oscillation. If the body, statically unbalanced, is operated at a speed corresponding to the period of oscillation, the oscillations of the frame will become violent, and can be readily registered by any suitable dial-gauge indicator. Here the body is imposing its own period on the frame, which thus performs what are known as forced vibrations of the same period. Our task is then to adjust the speed of the body so that the period of such forced oscillation will be equal to that of the natural oscillation of the frame and body (at rest).

In Lord Rayleigh's remarkable book* a most lucid explanation is given of this phenomenon of "step" or synchronism. Lord Kelvin's well-known device called a "vibrometer" is likewise based on this very principle. Of course, it is easy enough to see that a clamp K can always be so adjusted, both angularly and as regards its off-centre position, so as to nullify the oscillations of the frame, thereby solving the problem of static balance. No matter how heavy the body, it is always possible to place it into most minute balance by this method, where ordinary parallels would be altogether inoperative.

Dynamic Balance.—As regards dynamic balance, due, in a statically-balanced body, only to the presence of a centrifugal couple, the following remarks can be made: In the first place the "theory" that this centrifugal couple is due to the fact that the centres of gravity of both halves of the body, out through its centre of gravity, do not lie on the axis of rotation, is radically wrong. Take, for instance, a skeleton body shown in Fig. 6. Its centre of gravity is exactly on the axis of rotation, as also are the individual centres of gravity of each half, to the right and to the left from A to B. Yet such a body would be manifestly out of balance (dynamically). Inversely, a body would readily be imagined to be both in static and dynamic balance, although each of its halves were statically out of balance. The only correct way to characterise dynamic balance is to say that the products of inertia, containing the axis of rotation, vanish†; or, to put it practically, that there is no centrifugal couple in any axial plane.

In the next place, if we constrain (pivot) one end of a rotating body (statically balanced but dynamically out of balance) while the other end is arranged to float in a bearing supported by springs so that it may move, say, in a horizontal plane, Fig. 7, then the oscillations of the body will be angular, as from A to B. Under these conditions the observer will be unable to tell whether the vibrations are due to a force (centrifugal) acting somewhere on the body or to a centrifugal couple, unless he knows beforehand that the body is in perfect static balance, under which conditions the vibratory effect can be due only to dynamic unbalance. This being the case, in view of the reaction of the constrained end, it is perfectly possible to balance the effect of a centrifugal couple by means of a centrifugal force. Thus, in Fig. 8, if it is assumed that the dynamic unbalance is due to the couple a–b, it will always be possible to select a centrifugal force c, such that it will quiet the vibrating body, and because of its known distance from the bearing B, establish the exact value, sign and angular position of the disturbing centrifugal couple a–b.

It is thus clearly seen that it is possible to utilise a centrifugal force to good advantage in finding both static and dynamic unbalance of bodies; and combining the principles illustrated in Figs. 7 and 9, we have a combination static and dynamic balancing machine, of which the scheme is as follows:—

Description of Improved Balancing Machine.—A frame F, Fig. 10, supports the bearings B and C, which carry the body. The frame has a swinging period of its own. The bearing C may either be locked, so that it acts exactly like the rigid bearing B; or else it may be allowed to float in a vertical plane, bringing into play certain resistances (springs) opposing its deflection from the neutral (vertical) position. The correcting centrifugal force is indicated by K.

Such a system is known in dynamics as a system with two degrees of freedom, in general being capable of two kinds of motion: swinging of the frame, the bearing C being maintained rigid; and swinging of the bearing C, the frame F being maintained rigid by such means as brackets S; while the most general motion consists of a combination of these two motions.

The operation of such a combination machine is very clear. In order to secure static balance we lock the bearing C and unlock the frame supports S. Then, by properly adjusting the magnitude and direction of K we can reduce to zero the bodily oscillations of the frame F, thus establishing the exact value and sign of static unbalance in ounce-inch units. As soon as this has been corrected, we lock the frame F and unlock the bearings C, when the same centrifugal force K, created by a suitable adjustment of the clamp as explained above, can be made to correct the body for dynamic unbalance, as illustrated in Fig. 7. The advantage of basing the results on the centrifugal force instead of on a centrifugal couple is manifest, the former being a fundamental, and the latter a derived, unit, so that the former is capable of much greater accuracy in adjustment and of more direct application than the latter.

Fig. 11 illustrates a balancing machine built in accordance with the scheme of Fig. 10. The yielding support, clearly shown on the right, has means for easy adjustment of its period, as likewise has the frame itself. The motor is of ¼ h.p. capacity and operates the body, through a countershaft, by a rubber belt. The balancing clamp is seen on the extreme right of the crankshaft. The oscillations are read by means of ordinary Starrett dial gauges, graduated in thousandths of an inch. The precision which can be secured on such a machine is almost uncanny; it enables one to see the sluggishness of the method of balancing on ways and therefore the absolute lack of precision of dynamic balance that might be based on such results. A well-designed clamp is very easily handled and its correct position can be established in a few minutes. Its indications are capable of tabular interpretation, so that the operator has merely to carry out the simple instructions, worked out beforehand. Of course, it is clear that such a machine can be built for any size of body, or for any speed that may be desired.

* "Theory of Sound."

† Slocum, "Theory and Practice of Mechanics," page 297.

EXTENSION OF GERMAN POTASH WORKS.—The projected extension and increased output of the potash works in Germany was opposed in certain quarters, because the deterioration by the refuse waters of the various rivers, which join either the Weser or the Elbe, made itself felt in the potable water, in works (by the erosion of boilers), in agriculture and in the fisheries. The trouble was not serious, but grumbling was also caused by the circumstance, that the Governments of the small States, which come into question, Anhalt, Braunschweig and Sachsen-Weimar, were more ready to grant concessions than the Prussian Government was. The famous salt mines, frequently comprised under the name of the Stassfurt mines, are really spread over the territories of the four States mentioned. Further restrictions have recently been agreed upon, and the concessions have been renewed for a period of twenty years.

WOLFRAM MINING IN QUEENSLAND.—From the Queensland Annual Report in Mining, just published, we take the following notes relating to wolfram; "The stable markets for wolfram and molybdenite established by the Imperial Government over two years ago have been reflected by a corresponding stability on the part of those miners who are occupied in producing these minerals. While there has been nothing to complain of as far as the basic prices are concerned, much reasonable dissatisfaction has been expressed at discrepancies between the actual and the estimated cost of transit between the wolfram mining camps of Queensland and London. The chief centre of the production of the minerals named is the Cairns hinterland, which includes the Herberton and Chillagoe mineral fields: and an important factor in the past year's history of this part of Queensland has been the erection at Bamford of a State reduction and concentrating plant for the treatment of ores containing wolfram, wolfram-bismuth, molybdenite, and all three minerals combined. Extra machines are being installed to include the treatment of tin ore. In addition to providing facilities for the immediate neighbourhood, it is anticipated that the central position of the new mill will induce prospectors to search for fresh deposits throughout those belts of country where traces of wolfram and molybdenite are known to exist. The chief producers of pure wolfram in the Herberton district—and, indeed, within the Commonwealth—are the Mount Carbine Mines where the increased output has not detracted from their future stability. Nearly the whole of the stone has been obtained from the Irvinebank Company's mines, and won chiefly from stopes below No. 3 level in lease No. 2,225. It has been treated at the company's battery for returns of between 1 per cent. and 2 per cent. wolfram, assaying rather better than 70 per cent. for tungstic acid, latest crushing yielding the improved values. During most of the year much difficulty has been experienced in providing sufficient water for crushing purposes, and further development of the mines by sinking and driving is now becoming urgent. The magnitude and quality of the Mount Carbine wolfram deposits are worthy of more serious consideration than they have yet received as regards cheaper power for mining and milling purposes. The centre now ranking second among the greater producers of wolfram is Wolfram Camp, or Wolfram, but there it is always in association with bismuth and molybdenite, the product generally being a mixture of bismuth and wolfram. The bulk of the stone is sent to the Wolfram Mill, which has, during the year been subjected to complete reorganisation, tending towards economy, efficiency and completeness of treatment. These changes caused some stoppages of the mill, which resulted in temporarily reducing employment and production at the mines. While special prominence cannot this year be claimed for any individual mine, amongst the foremost producers may be ranked the Murphy and Geaney, Larkin and Wade, Hughes, and Tully Tribute, while good and consistent patches have been worked in the Enterprise, Mount Maguire, Leisner's Wolfram Block, and several others."

KRUPP'S BALANCE SHEET.

THE Krupp firm has not been quite so successful during the last financial year, 1916–17, as during the previous year, according to their last balance sheet, particulars concerning which have been forwarded to us. The working profit of all the company's undertakings for the year 1916–17 amounted to 89,065,406 marks, as against 96,928,938 marks for the preceding year. The profit is further increased by a sum for interest of 6,930,585 marks, as against 3,283,333 for the preceding year, and sundry items amounting to 7,895,604 marks, as against 3,670,963 marks, making a total of 103,891,595 marks for 1916–17, as against a total of 103,883,234 marks for 1915–16. To these totals should be added the amounts carried forward the preceding years, *i.e.*, 11,002,121 marks for the year 1916–17 and 9,477,678 marks for the year 1915–16, making the revenue 114,893,716 marks and 113,360,912 marks respectively.

On the expenditure side, we find the following items, the figures for 1915–16 being given in parenthesis: Taxes, 30,899,115 marks (28,649,923 marks); employees' insurance, 8,304,854 marks (6,935,117 marks); welfare expenditure, 23,712,170 marks (18,140,886 marks).

The profit, including the balance carried forward, amounts therefore to 51,977,577 marks for 1916–17, and to 59,634,986 marks for 1915–16.

From the net profit, a sum of 2,048,823 marks is added to the ordinary reserve, as against 2,482,865 marks in the preceding year; a sum of 5,000,000 marks has been carried to the special reserve, as against 2,000,000 marks; the dividend has been fixed at 10 per cent., as against 12 per cent.; and a sum of 14,679,754 marks has been carried forward, as against the 11,002,121 marks above referred to.

The following items taken from the balance sheet are interesting: The land, buildings and plant are included for 243,853,586 marks; tools and means of transport for 2,351,290 marks; stocks of half-finished and finished products for 584,225,177 marks, against 368,833,955 marks in 1915–16 and 235,244,856 marks in 1914–15; fixed interest stocks, 135,392,508 marks.

SCIENCE AND WAR.—In a paper read recently at Chicago, Major R. A. Millikan, Professor of Physics in Chicago University, stated that war was 85 per cent. science and engineering and 15 per cent. actual fighting. As one application of science he mentioned that it had proved practicable to locate the position of a heavy gun within 50 ft. by observations on the sound waves set up on its discharge.

DRYING BLAST-FURNACE AIR BY CALCIUM CHLORIDE.—In a paper read before the Engineers' Society of Western Pennsylvania, Mr. Leon Cammen, 29, West Thirty-ninth-street, New York, described a process of drying air for blast-furnace use, by passing it through a highly concentrated solution of calcium chloride maintained at low temperature. The process is referred to in *The Iron Age*. Cold brine enters the top of the drier and flows counter-current to the air entering at the bottom. Leaving the drier, the brine passes through an evaporator, where its initial concentration is restored, after which it is cooled to a temperature proper for use by a stream of water supplemented by a counter-current of cold brine going to the evaporator. In the evaporator only a concentration of the brine and not drying of the salt is effected as comparatively low temperatures must be used.

SYNTHETIC GASOLINE PRODUCTION.—Mr. L. B. Cherry, who recently took out a patent on the synthesis of gasoline by electric discharges, somewhat as in the Cottrell dust precipitation, communicated some of his experiments to the October meeting of the American Electrochemical Society. He works with mixtures. Starting with vapours of heavy hydrocarbons (a kerosene of density 0.81) and natural gas (or methane) at a pressure of 75 lb. per square inch, and tubes 3 ft. long, in which the gases were exposed to high-frequency discharges at 40,000 volts, 56 per cent. of the kerosene were transformed into products distilling between 45 deg. and 160 deg. C., and of the average density of 0.75. By increasing the length of the tubes to 10 ft. and raising the volts and the frequency, the conversion was increased to 78 per cent. The total cost of the electric energy for the gasoline conversion was estimated at 0.6 cent per gallon, assuming electricity supply at 0.6 cent per kilowatt-hour.

EXTENSION OF THE MANNESMANN TUBE CONCERN.—The Mannesmann Tube Works has decided to increase its capital by 14,000,000 marks new shares, which are entitled to half dividend for the current year, 1917–18. This fresh issue takes place on account of the Mannesmann concern having acquired the Unser Fritz Gewerkschaft, at Unser Fritz, Wanne, and having to give 14,000 marks of the new shares for each portion or "Kux" in "Unser Fritz," in addition to a sum in cash, the dividend for the last quarter of 1917 going to the previous owners. The deal can hardly be considered final as yet. The reason for the Mannesmann concern being desirous of securing further coal mines is to be found in the fact, that their mine, "Königin Elisabeth," is not likely to be workable, from a technical point of view, with advantage for several years to come as far as long flaming and gas coals are concerned, and these kinds of coal are particularly essential with a view to certain finished manufactures, which the company is likely to take up. The deliveries effected by the Mannesmann Company from July 1, 1917, to November 30, show a very material increase compared with the corresponding period of last year.

NOTES ON WELDING SYSTEMS.*

By CAPTAIN JAMES CALDWELL, M.I.E.E., R.E.

THE author deals first with the principles of welding, and then with smith welding, with electric welding by (1) the butt method, (2) the spot method, and (3) the seam method, with welding by water-gas; with fusion welding by (*a*) flame blowpipe, (*b*) oxy-acetylene, (*c*) oxy-coal-gas, with thermit, with the carbon arc, with the metal arc, including (1) bare metal electrodes, (2) coated metal electrodes, with (*a*) the gaseous flux process and (*b*) the liquid flux process. The paper closes with an account of typical plant. It is the section on welding with coated metal electrodes which is dealt with in the following extract.

COATED METAL ELECTRODES.

(*a*) *Gaseous Flux Process.*—In this process, which was originally patented and developed by Kjellberg, the metal electrode is covered with a fireproof sleeve of non-conducting material, so that as the metal is removed by the arc the sleeve projects beyond the end of the rod, forming a guide for the molten welding metal, the sleeve itself falling away automatically. This sleeve also protects the metal from oxidation and reduced heat losses.

It is an improvement on the bare metal electrode, and a great deal of satisfactory work has been done with it, namely, in repairing marine boilers, stern frames and other ship parts. It is also successfully used to build up worn parts, such as propeller shafts, worn crankshafts and axles, which are afterwards machined to size. The patent claims the use of no particular material for the fireproof sleeve, and no other purposes than those mentioned, but the company exploiting the process claims that it can be made the vehicle of constituents which will give desired characteristics to the added metal.

(*b*) *Liquid Flux Process.*—In this process, invented by Strohmenger of the Quasi-Arc Company, a sleeve or covering is applied to the electrode, and the material of this sleeve is such that it melts and forms a flux covering the end of the electrode and the added metal, thus protecting both from oxidation. The flux may contain constituents having a chemical action upon the fused metal, to improve its qualities. As originally used, the electrode was laid along the line of the weld, connected to one pole of the circuit, and an arc started at one end which travelled along the line fusing both the work and the electrode metal and leaving the weld covered with the flux. It was found better, however, to clamp the rod in a holder, moving it by hand along the length of the weld at a suitable rate and giving it at the same time a swinging movement across the line of weld, as is done in blowpipe welding. The arc is formed entirely within a sheath of molten flux, so that the metal is at no time exposed to oxidation. The arc is very short, about $\frac{1}{4}$ in. as a rule. Incidental advantages of this method include smaller heat losses from the arc, and that work can be done with a lower expenditure of energy than by any other arc methods.

The covering material used generally has asbestos as a basis which is impregnated with salts calculated to combine with the asbestos to form a mixed silicate flux or slag of suitable viscosity and with the property of cleaning the metal surfaces from oxide, &c. The viscosity of the molten slag is of importance. It must be sufficiently fluid to permit the free movement of the rod working in it, and to free itself from the molten metal, but not so fluid that it is blown away from the weld by the gases escaping from the arc. Different makers use different compositions, and it is probable that some variation is desirable to suit different metals. Some experiments are being made with fluxes of a "basic" character instead of "acid" silicates, presumably to reduce the amount of silica in the metal. In some cases the fluxing material is put on the electrode rods in a plastic condition by forcing through dies, and in other makes part of the flux constituents are placed in the form of a powder in a tubular or channel electrode.

The material of the rod can also be varied to suit the work. For example, nickel-plated rods are made for the special purpose of welding high-speed tool steel into mild steel shanks. Compound rods are made, and an aluminium ribbon or wire is sometimes wrapped round the rod, before the flux coating is applied. Since the fused electrode metal is protected from oxidation by the flux it can be so compounded as to give a welding material of any desired composition which is of considerable importance when the weld has to resist high stresses, or when the added metal has to act as a reinforcement or has to be machined to form a working part or surface. There is a great deal of experimental work in process on these lines, and whilst some of the results may have little more than advertising value, others of material importance have already become known.

The fluxed metal arc process is certainly of the greatest promise for constructional welding, as for example, in shipbuilding. Trials already made on full scale show that in some respects it is superior to riveting. Actual experience in ships in service is wanted to show whether these last results are borne out in practice, because no testing machine can reproduce the complete stresses endured by a ship in service. There is already good reason to say that if welding can replace riveting there will be a considerable saving in material and labour in shipbuilding. Whether an all-welded ship is practicable or not, this method of welding is satisfactory for a large number of constructional details.

Butt joints must be suitably prepared by veeing and fitting. Plates under $\frac{1}{4}$ in. thick need not be veed, as complete fusion for this depth can be assured. The angle of the V should be no larger than to permit the end of the electrode to get well down to the lower surface. In thick work it is usual to apply several layers to get full thickness. The slag should be removed from each before another is applied, and the surface brushed bright with a wire brush.

The rod is held at right angles to the face of the work. Care is necessary to maintain the arc at the proper length. If the electrode touches the work it will probably stick. It should be fed down at the rate at which it melts, or the arc will break from the great length. Excessive length of arc, short of the breaking point, tends to produce porous metal. The rate of feed along the joint should be steady so as to produce a layer of even thickness. Interruptions should be avoided, and when unavoidable—as in coming to the end of an electrode—the metal should be thinned out for a short distance and thoroughly re-fused when starting again. The light and heat given off from the fluxed metal is much less than from the carbon arc, but screening of the face is necessary to protect the eyes from glare and sparks by tinted glass let into a light frame which is held in the hand.

* Extract from a paper read on January 22, before the Institution of Engineers and Shipbuilders in Glasgow.

THE DANISH MERCHANT NAVY.—During 1917 the Danish merchant navy has lost 128,780 tons gross through war casualties, against 58,600 tons in 1916, 23,990 tons in 1915 and 9,203 tons in 1914. The loss of Danish seamen through the war amounts to 219 lives from the beginning of the war to the end of 1917.

THE MONT D'OR TUNNEL.—The Mont d'Or Tunnel, built in the years 1910 to 1915, was planned more than 30 years ago, but the problems were not seriously approached until after the completion of the Simplon Tunnel. The tunnel is on the line from Frasne, in France, to Vallorbe, in Switzerland, and it was projected in order to shorten the international railway route by the "ligne de Jougne," which had been built as a makeshift in 1871, by 20 km., to reduce the gradients of 25 per mille maximum, and to lower the culminating point from 1,012 m. down to 894 m. above sea level. The Mont d'Or forms the north-eastern end, between Longueville and Jougne in France, and Vallorbe in Switzerland, of a ridge which extends parallel to the frontier on French territory, and reaches a height of 1,463 m. The tunnel runs from Longueville (level, 894 m.) in a length of 6,097 m., with a gradient of 13 per mille, down to Vallorbe (816 m.): five-sixths of the tunnel are rectilinear, only the entrance to Vallorbe is curved, being an arc of 685 m. length (radius of curvature, 700 m.). The water caused very serious difficulties during the operations, and it is to these and to their geological character, that Dr. H. Schardt, of Zürich, devotes a series of four articles in the December numbers of the *Schweizerische Bauzeitung*. The smooth folding of the surface formation did not suggest any particular distortions and water troubles. When operations began in November, 1910, on the Swiss side, from which most of the work was done, and in June, 1911, from the French side, the disclosed stratifications, though not badly distorted, and the character of the limestone and marls, prepared the engineers for inrushes of water. The troubles were far worse than expected, however, in the fifth group of sources, which was struck in December, 1912, at 4,273 m., from Vallorbe. A cleft, about 60 cm. wide, filled with a yellow loam, did not at first discharge water. When the tunnel had been pushed 93 m. further, however, this loam, which had gradually become soft, was driven out, and water burst into the tunnel at the rate of about 3,000 litres per second. The tunnel was flooded, and a great wash-out occurred at the Vallorbe end. On the same day, one of three springs, lying about 5 km. north-east of the tunnel, at levels from 79 to 84 m. higher than the tunnel, began to run dry, and the other two stopped two days later. The builders were faced with claims for heavy damage done, not only by the flood, but also by the tapping of these sources. When the inrush of water quieted down, the water was temporarily deflected through the ventilation conduit, the cleft was stopped below, and the whole tunnel was barred at the spot by a concrete dam, through which two pipes were laid, one supplied with a valve. The valve was closed on January 19th; the water pressure rose, first rapidly, then more slowly and irregularly; within 48 hours the first of the three springs began to flow again, and the others followed. In order to trace the water current, fluorescein was added to the water; this was successful, though the fluorescein did not rise in the quiet water behind the dam. Later the dam was removed again by blasting: the advance had not proceeded far, however, when, at 4,407 m. from Vallorbe, a drill was shot out of its hole, and water again flooded the tunnel, this time at the rate of 10,000 litres (over 2,000 gallons) per second. The new springs and the old ones, it was found afterwards, were interconnected by some channel underneath the tunnel. All the difficulties were, however, overcome, and the tunnel was opened in 1915. Finally, out in the open, between Longueville and l'Abergement, a great moor had to be crossed by the railway. This moor forms the ancient basin of two lakes which are now joined by the Doubs River. A viaduct, 360 m. in length, was first planned: but soundings down to depths of 65 m. found no rock bottom. Then a bank was built, which, sinking, pressed the ground near it up, and it proved clear that the Doubs would have to be deflected in a curve, so that it might be bridged on rocky ground. As the rock was wanted for building the dam, and as there were level difficulties, the new course of the Doubs had partly to be made subterranean. In the middle of the lake the embankment subsided altogether by fully 40 m., and the track had to be relaid several times.

STATE AND MUNICIPAL ELECTRIC STATIONS IN PRUSSIA.

THE State of Prussia is about to erect a large steam-driven electric power station, to be known as the Hannover Power Station, with a capacity of some 50,000,000 kw.h., in connection with which the Minister for Public Works has issued a programme. The leading principle will be that the State, as a general rule, will confine itself to the generation and to what may be called the wholesale distribution of electric energy; it will not interfere with the distribution to the consumers. There is to be close co-operation with the existing municipal electric stations and the municipal unions, on which will fall the main work of current distribution. Existing municipal or private electric undertakings are not expected to discontinue their operations, but it is surmised that these undertakings will decide to take the current offered them by the State, as they will be able to obtain it at a lower cost than that of their own current. On the other hand, a certain degree of State interference or control may be looked for, as far as the free development of private and municipal electric works is concerned, more as regards the erection of new electric stations than the working of those already in existence. The State scheme is also to prevent the building of new inadequate stations, and provides a rational delimitation of the distribution areas.

This resolution on the part of the State has naturally caused some alarm among existing works, and the Union of Electricity Works, which principally comprises municipal generating stations, has given expression to the following views and objections. The Union can raise no objection to the Prussian State having decided to participate in the supply of current, but in the interest of the national industry any opposition should be avoided between the new State owned stations and the existing ones of fair capacity. The Union therefore hopes, that the State authorities will pay some attention to the views set forth below:—

1. The development of existing electric stations of fair capacity should not be interrupted by being made dependent upon State permission for their extension, either in regard to generating plant or to distribution.

2. The State electric stations to be erected should be limited to the generation of current and its transmission in bulk; they should not supply large consumers, inasmuch as the supply of current to such consumers is the revenue of the existing electric stations.

3. In the planning and erection of new State electricity works, the question of their real necessity should be most carefully gone into, and State electricity works should not be erected when existing municipal and private undertakings already adequately provide the area in question with current.

Doubts have been expressed as to whether the State is likely to fall in with all or perhaps any of the above views. If private or municipal initiative is left full scope as far as extensions are concerned, both private and municipal plants will, of course, be far better able to compete against the State works. The State is not likely to forego its right to supply large consumers, since many large industrial concerns would be ready to shut down their own electric generating stations when they saw they could obtain cheaper current from the State.

LITHIA IN EDISON STORAGE BATTERIES.—Little has been heard of late about the iron-nickel-alkali cells of Edison. According to recent papers, however, the addition of lithia—which, we think, was proposed years ago—is once more recommended for increasing the capacity of the cell, though the resistance is increased. To the 21 per cent. solution of caustic potash, 50 grammes of lithium hydroxide solution, saturated at 24 deg. C., are added; the resistance is said to increase by 21 per cent., but the capacity to rise by 12 per cent.

NEW SWEDISH MOTOR VESSEL.—A new motor vessel, possessing special features, has recently been built by the Norrköping yard. She is intended for the herring traffic between Iceland and Sweden, is entirely of oak and pine, all open fittings and mountings being of metal. She has a capacity of 650 tons and only draws 10 ft. The propelling engine is a reversible crude oil motor of 270 b.h.p.; the oil supply amounts to 60 kg. (132 lb.) per hour. Oil and water tanks are calculated for 30 days at sea. The vessel is fitted with heating pipes, electric lighting, electric winches, &c.

MAGNESIA FOR FURNACE LININGS.—Californian magnesite which contains 98 per cent. of $MgCO_3$ is said to make a very good lining for electric furnaces of the Massano type, in which ferro-alloys, tungsten, &c., are to be prepared. According to R. C. Goavow (*Metallurgical and Chemical Engineering*, 1917, page 415 to 417) the magnesite was broken into lumps of about 2 in. or 3 in. and calcined in oil-fired shaft furnaces; the resulting magnesia contained 94.7 per cent. of MgO and about 2 per cent. of iron oxide and alumina. Disintegrated to grains of $\frac{1}{4}$ in. the magnesia was partly fused in a Massano furnace; it turned into a hard mass which scratched glass and did not noticeably take up moisture in ten days, but yet increased in weight afterwards. The dead-burned product was ground and mixed with 10 per cent. of powdered ferric oxide, 5 per cent. of basic-steel furnace slag, and 12 per cent. of well-boiled tar. The mixture was then rammed into the furnace. Though considerable percentages of iron oxide and tar were used, it is advised to keep these percentages low and to make the magnesia lining thin.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

SELECTED ABSTRACTS OF RECENT PUBLISHED SPECIFICATIONS UNDER THE ACT OF 1907.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, &c., of the Communicators are given in italics.

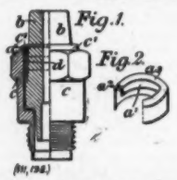
Copies of Specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery-lane, W.C., at the uniform price of 6d.

The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.

Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any grounds mentioned in the Act.

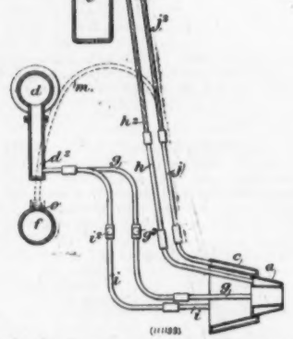
GAS ENGINES, PRODUCERS, HOLDERS, &c.

111,198. H. G. Longford, W. W. Longford, and W. A. Clark, Birmingham. Ignition Plugs. (2 *Figs.*) January 12, 1917.—This invention relates to sparking plugs of the type in which a packing material is incorporated between the insulator and casing encircling same in such a manner that the said packing material adheres to both the said insulator and the said casing. According to the present invention, in this type of plug there is incorporated between the insulator and the casing an annulus which is adapted to confine the packing radially outwardly as well as longitudinally. The ring or sleeve *a* is of copper of annular formation, the one end being turned inwards to form a



flanged neck a^1, the flange of which is arranged to fit the insulator *b*, the flange a^1 being extended a sufficient distance to form an internal annular channel or cavity a^2 between the outer and inner part of the ring or sleeve. The annular recess a^2 is filled with the vitreous material *d* in plastic or dry form, after which the ring or sleeve *a* is forced into position between the insulator *b* and the outer casing *c*, where it is secured by the pressing or spinning over of the outer edge c^1 of the outside casing *c* on to or above the bend a^3 of the turned-over part of the ring or sleeve *a*, the plug being then subjected either to a process for drying the cement or to the necessary heat for fusing the vitreous material *d*. (*Accepted November* 28, 1917.)

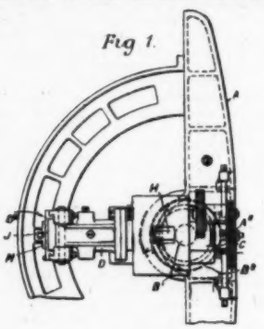
111,199. W. J. Foster, Walsall. Tuyeres. (1 *Fig.*) January 17, 1917.—The invention relates to the water circulation through tuyeres and coolers of blast-furnaces of the kind using a pressure water supply and a trough or other system of discharge, and consists in providing as part of the system on the discharge side a partial vacuum main and means for conveniently and quickly connecting thereto the discharge side of any tuyere or cooler which may burn out. The tuyere is shown at *a* and the cooler at *c*, a water pressure supply main at *d*, a discharge trough at *e*, and a partial vacuum main at *f*. *g* is the water supply pipe to the tuyere, being connected up to a branch d^2 of the pressure main, and *h* is the discharge pipe from the tuyere to the discharge trough *e*, the part h^2 of said pipe being of flexible form. Similarly, *i* is the water supply pipe to the cooler *c* leading from the supply main branch d^2, and *j* is the discharge pipe from said cooler

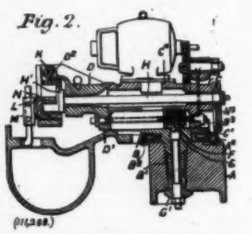


emptying into the discharge trough *e*, the portion j^2 of this discharge pipe being of flexible form. The invention applies to the system the partial vacuum main *f* and arranges the discharge pipes *h* and *j* so that they can be easily and quickly removed from the trough *e* and connected up to the partial vacuum main *f* in a manner indicated by the dotted lines *m*, said vacuum main *f* having a suitable number of connections as at *o* for the rapid attachment of said pipes. The water supply pipes *g* and *i* may be fitted as indicated at g^2, i^2, with stopcocks whereby the amount of water fed to the tuyere and cooler can be regulated and the pressure reduced in relation to the internal pressure of the furnace adjacent to the tuyere or cooler and the pull of the vacuum main, it being thereby possible under all conditions of burning out to still cool the burnt-out tuyere or cooler without allowing the cooling water to leak into the furnace. (*Accepted November* 28, 1917.)

MACHINE AND OTHER TOOLS, SHAFTING, &c.

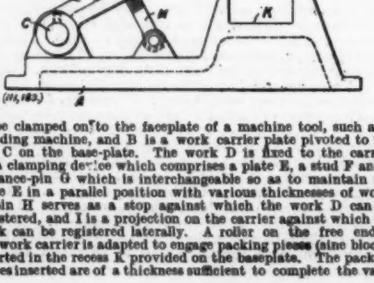
111,268. J. Samuel White and Co., Limited, East Cowes, and A. Forster, West Cowes. Slotting Machines. (5 *Figs.*) August 20, 1917.—This invention relates to slotting machines. A frame member A carries a bedplate B provided with a pivot-pin B^1, which lies in a hole in the frame A. The bedplate B carries about the pivot-pin B^1 a worm wheel B^2, with which gears a worm A^2 on the frame A. By means of this worm A^2 and the wheel B^2 the bedplate B can be swung into any position about its pivot B^1 on the frame A. The upper part of the bedplate B is formed as a slide, on which rests a member or casing so as to be movable on the slide in a radial direction with relation to the pivot B^1. This member is formed of two parts, C and D, connected together. The part C comprises a downwardly-directed portion C^1, which rests on and engages the slide B^3, a main-body portion and an upper plate C^2 on which is mounted an electric motor E. The part D is bolted to one end of the part C and comprises a downwardly-directed portion D^1, shaped to engage the slide B^3 and a lug D^2 on its upper part which overhangs the end of the part D. A feed screw F is carried by the parts C^1 and D^1, and this screw passes through and engages a correspondingly screw-threaded block G mounted on the end of a spindle G^1, which passes downwardly through the pivot-pin B^1. One end of the screw F is squared to permit of the screw being rotated for the purpose of moving the member or casing D in a radial direction with relation to the pivot B^1. The member C, D is formed hollow about its centre portion and has its ends constructed as bearings, which carry a power shaft H. On that end of the shaft which projects





beyond the part D is a disc H^1 provided with a crank-pin. On the opposite end of the shaft H which projects beyond the part C is mounted a gear wheel H^3. The tool-box J is provided at its upper part with two lugs J^1, and a pin K is passed through these lugs and through the lug D^2 so that the tool-box is thereby pivotally suspended from the part D. Within the tool-box is mounted a member which forms part of or to which is fixed the tool holder M. The member L can move vertically in the tool-box J so as to impart the necessary reciprocating movement to the tool. The interior of the member L is hollowed out to constitute a cylindrical guide, the axis of which lies in or about the same plane as, but at right angles to, the portions of the tool-box J which serve to guide the member L in its reciprocating movement. In this cylindrical guide lies a block N shaped so that it can both reciprocate in the guide and also oscillate therein about the axis of this cylindrical guide. An opening is formed in the rear side of the guide member L and through this opening passes the crank-pin, which so engages the sliding block N that the crank-pin can slide freely in and out of the block N. Thus, as the shaft H rotates, the crank-pin will cause the block N to reciprocate in the guide, while the guide member L will be caused to reciprocate in the tool-box J, thereby imparting the necessary movement to the tool. (*Accepted November* 28, 1917.)

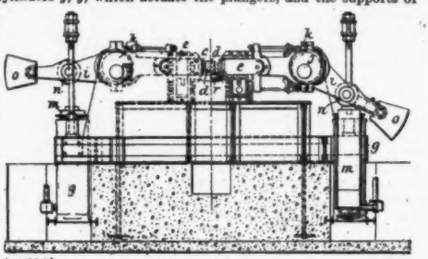
111,183. A. Herbert, Burford, and G. Kelway, Earlsdon, Coventry. Machining Angular Pieces. (1 *Fig.*) December 4, 1916.—This invention relates to improvements in sine bar devices of the kind which is adapted for holding the work at the desired angle while it is being machined, and which comprises a baseplate, a work-carrier plate pivoted thereto, means to clamp the work on the carrier, and means to clamp the work carrier at the desired angle against an adjustable block inserted between the baseplate and the work carrier. According to this invention, the work-carrier plate is provided at its free end with a roller to engage the sine blocks, which are placed upon a machined surface on the baseplate. A is a baseplate adapted

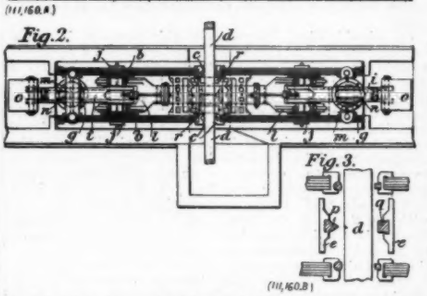


to be clamped on to the faceplate of a machine tool, such as a grinding machine, and B is a work carrier plate pivoted to the pin C on the base-plate. The work D is fixed to the carrier by a clamping device which comprises a plate E, a stud F and a distance-pin G which is interchangeable so as to maintain the plate E in a parallel position with various thicknesses of work. A pin H serves as a stop against which the work D can be registered, and I is a projection on the carrier against which the work can be registered laterally. A roller on the free end of the work carrier is adapted to engage packing pieces (sine blocks) inserted in the recess K provided on the baseplate. The packing pieces inserted are of a thickness sufficient to complete the value of the sine of the angle to which the work carrier is to be tilted, so as to bring the face L of the work D into the desired position for machining. The work carrier is clamped firmly on to the packing pieces by the pivoted stud M and nut N. (*Accepted November* 28, 1917.)

MINING, METALLURGY AND METAL-WORKING.

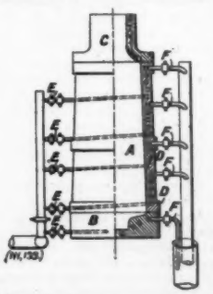
111,160. The South Durham Steel and Iron Company, Limited, Stockton-on-Tees, E. Crowe, Saltburn-on-Sea, and J. Rees, West Hartlepool. Breaking Metal Bars. (3 *Figs.*) November 16, 1916.—This invention relates to machines for breaking metal bars. According to this invention, opposed plungers and opposed pairs of spaced supports or abutments are employed, and the plungers are actuated to successively perform the nicking and breaking operations without having to turn the bars over. The frame of the breaking press, which rests upon a suitable concrete bed *a*, comprises main side frame members *b*, *b*, having notches *c* at the centre to allow the bar *d* to be placed in position to be broken. On this frame the operative parts of the press are mounted. These include the two horizontally-opposed plungers *e*, *e*, which reciprocate in guides fixed between the sides of the frame, the vertical hydraulic cylinders *g*, *g*, which actuate the plungers, and the supports or





abutments which are fitted to the sides of the notches *c*. Between the plungers *e*, *e*, and their actuating cylinders *g*, *g*, are the levers *i*, *i*, working on fulcrum pins *j*, *j*, fixed in the side frames and formed with pairs of eccentrics *k*, *k*, coupled to the plungers by forked eccentric rods *l*, *l*. The rams *m*, *m*, which actuate the plungers through the levers *i*, *i*, and eccentric rods *k*, *k*, bear against rollers *n*, *n*, mounted in the levers. Weights *o*, *o*, are provided on the outer ends of the levers to return the plungers promptly after the power strokes. As clearly shown in Fig. 3, the nicking block, formed of a knife-edge block *p*, is attached to one of the plungers *e*, and the plain breaking block *q* is attached to the opposite plunger. The bar *d* to be broken is fed over rollers *r* between the opposed plungers and supports or abutments, and is operated upon by the nicking and breaking plunger in succession, as will be readily understood. (*Accepted November* 28, 1917.)

111,133. Sir W. G. Armstrong, Whitworth and Co., Limited, and H. H. Ashdown, Newcastle-upon-Tyne. Casting Steel Ingots. (1 *Fig.*) November 10, 1916.—According to this invention, the sides of the ingot are cooled until the metal has solidified preferably to a considerable thickness, and the ingot is then cooled from its base upwards in order to effect the solidification of the still liquid central portion from the base upwards. By this process segregation is confined to the top of the ingot. A is a mould having a bottom plate B, and in the mould and plate are pipes D for the circulation of the cooling medium, the supply to the various pipes being controlled by a series of cocks E. The cooling medium is discharged from the pipes D by the pipes F. By opening the lowest cock E the bottom plate alone is cooled, and similarly any section of the



mould may be cooled as desired. In casting the ingot, the metal is fed through a feeding head C, and in the course of working the cocks E are opened in succession upwards as the liquid metal reaches the part of the mould cooled by each section of pipes. The effect of this is to promote a much quicker solidification of the metal in proximity to the cooled walls of the ingot mould for the entire length of the ingot, causing the segregates to be forced to the centre of the ingot. Finally, after the pouring of the metal is finished, the cooling effect of the lowest cooling coil in the wall of the mould and the coil in the bottom plate is increased so that the central portion of the metal which is still liquid is cooled from its bottom end upwards, forcing the segregates into the last portion remaining liquid near the feeding head. (*Accepted November* 28, 1917.)